REPORT OF
AIR POLLUTION SOURCE TESTING
OF AN ETHYLENE OXIDE EMISSION-CONTROL SYSTEM
OPERATED BY STERIGENICS, US, LLC
IN WILLOWBROOK, ILLINOIS
ON SEPTEMBER 20, 2018

WILLOWBROOK II FACILITY

Submitted to:

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
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Submitted by:

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Revision 1

OCTOBER 30, 2018

ECSi

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1.0 INTRODUCTION

Revision 1 was completed at the request of USEPA and IEPA. Revisions made to the report include:

- Conversion made from wet ppm to dry ppm formula added to Section 5.9.
- Section 8.0 Test Results show efficiency changed from ≥99.5133 to ≥99.5056%.
- Tables 1 and 2: Added columns to show dry ppm conversion values for inlet and outlet concentrations
- Tables 1 and 2: Included moisture/temperature calculation averages for each run.
- Tables 1 and 2: Mass Flow values were previously calculated in lbs./second and labeled lbs./minute. Edit made to show values in lbs./minute.

On Thursday, September 20, 2018, ECSi, Inc. performed air pollution source testing of an ethylene oxide (EtO) emission-control device operated by Sterigenics US, LLC at their Willowbrook II ethylene oxide sterilization facility located at 830 Midway Drive. The control device tested was a two-stage Advanced Air Technologies (AAT) Safe Cell emission-control system, comprised of a packed-tower chemical scrubber and a dry-bed reactor, used to control emissions from four sterilizer vacuum pumps, four sterilizer backvents, and two aeration rooms.

The purpose of the testing program was to demonstrate compliance with the conditions established in Section 6 of the Construction Permit (Application No: 18060020) granted to Sterigenics by the Illinois Environmental Protection Agency (IEPA) to control emissions from the sterilization chamber backvents. See Appendix L.

Test Protocols were submitted and approved by IEPA prior to testing. Copies of protocols and approval are included with Appendix L.

Representatives from Sterigenics were present during the testing as well as personnel listed below:

- Kevin Mattison, IEPA
- Ned Shappley, US EPA, OAQPS
- Margaret Sieffert, US EPA, Region 5
- Paul Farber, PE (Consultant for Village of Willowbrook)
- Lawrence Link, Tri-State Fire Department

2.0 EQUIPMENT

The gas sterilization and emission control equipment in Willowbrook II consists of the following:

- Four Sterilizers, each comprised of a steam-heated sterilization chamber, a vacuum pump chamber evacuation system, and a backvent valve;
- Two aeration rooms, each comprised of a heated aeration space.

Chamber exhaust, backvents, and aeration emissions are controlled by:

- One two-stage Advanced Air Technologies (AAT) Safe Cell emission-control system, comprised of a packed-tower acid/water scrubber (SC1), equipped with a packed reaction/interface column, a scrubber fluid recirculation system, and a scrubber fluid reaction/storage tank, and a dry bed reactor/scrubber (SC2), comprised of a bank of solid-bed reaction vessels containing Safe-Cell IIA Reactant for EtO control, connected in parallel, installed downstream of SC1 and upstream of a dedicated blower exhaust system designed to operate at 10,150 cfm.

3.0 RULE/COMPLIANCE REQUIREMENTS

The EtO gas-sterilization system at the Willowbrook II facility was tested to demonstrate compliance with requirements specified in the Construction Permit issued by IEPA (Application No: 18060020) and CAAPP Permit No: 043110AAC. The following requirements must be met:

- The existing emission control equipment for chamber exhaust and aeration room emissions is required by 40 CFR Part 63, Subpart O to achieve a control efficiency of 99% or greater.
- Chamber backvent emissions are not regulated through the federal regulations at 40 CFR Part 63, Subpart O. By way of permit application 18060020, Sterigenics has voluntarily elected to control backvent emissions using existing emission control equipment at the facility already required to achieve 99% or greater control efficiency.

Testing is required to demonstrate continued compliance with these requirements.

4.0 TESTING

EtO source testing was conducted in accordance with the procedures outlined inUS EPA Reference Methods 2, 3, 4 and 18. EtO emissions monitoring was conducted simultaneously at the inlet and outlet of the AAT System during the 15-minute duration of the backvent process. Three 15-minute test runs were performed.

4.1 TEST SCENARIO

Once a sterilization chamber cycle ends, a sample from inside the chamber is taken and measured to ensure the EtO concentrations are below 25% of the lower explosive limit (LEL) for safety reasons. Current controls interlocks will not allow the doors to be open if the concentration of EtO at the end of a cycle exceeds 25% LEL. Once this criterion has been met, the process requires the chamber door to be partially opened for 15 minutes which vents the EtO in the chamber to reduce levels in the chamber and exposure to employees. The 15-minute duration ensures the highest concentration of EtO is removed from the chamber prior to unloading the product. During this venting, EtO exhausts through the backvent and to the AAT scrubber. In accordance with the facility's procedures, workers are not allowed to enter or unload the chamber until the 15-minute time period has passed. Once the 15-minutes has passed, the product is unloaded to the aeration room.

To meet Condition 6 of the Construction Permit which requires conditions for testing to be conducted as representative of maximum emissions, each test run was completed on the backvents using freshly sterilized product from one chamber for a 15-minute duration, for a total of three test runs at each facility. The emission testing of the sterilization chambers occurred while running FDA validated cycles with higher ending EtO concentrations for testing. Each test interval tested the first 15 minutes the backvent is opened and exhausted to the AAT scrubber.

4.2 PROCESS PARAMETERS MONITORED

Based on the overall AAT scrubber liquor storage volume, relatively short duration of the test, and knowledge of the operation of the AAT system, the properties of the AAT scrubber liquor were not expected to change significantly during the test. Because of this, the AAT Scrubber tank level, pH, and

glycol concentration (measured via refractometer) were monitored and recorded before and after the performance of the three trial runs. Results are presented in Appendix A.

Cycle information for each test run, including ending EtO concentration in the chamber space, also was recorded. Emission levels from aeration also were recorded before performance of the three trial runs. Results are presented in Appendix A.

During routine operations, weekly concentration sampling of the AAT system is conducted using samples collected from the AAT system outlet using a Tedlar bag and the facility's gas chromatograph system. Since this performance testing involved real-time analysis of the inlet and outlet concentrations of the AAT system, Tedlar bag sampling was not conducted during these tests.

4.3 TESTING EQUIPMENT

Testing equipment information and certifications are located in Appendix G.

5.0 TEST METHOD REFERENCE

5.1 INTRODUCTION

EtO source testing was performed in accordance with US EPA Reference Methods 1, 2, 3, 4 and 18. EtO emissions monitoring was conducted simultaneously at the inlet and outlet of the AAT System during each 15-minute duration of the backvent process. A total of three test runs was performed.

During backvent testing, EtO emissions at the inlet and the outlet of the AAT Safe Cell System were determined using direct source sample injection into the gas chromatograph (GC). The GC used to analyze EtO concentrations was a SRI Model 8610 (also described in Section 5.3).

US EPA Method 1: Sample and Velocity Traverses for Stationary Sources (40 CFR 60 Appendix A)

Sample ports and flow traverse locations were located at the inlet and outlet of the AAT control device. Numbers of flow traverse locations were selected to exceed those recommended by Tables 1.1 and 1.2, and were spaced throughout the duct in accordance with Method 1. The average angle of cyclonic flow at each traverse point was less than the maximum average angle specified in Method 1. For further information on sample port locations, sample and velocity traverses, and cyclonic flow measurements please see Appendix B.

US EPA Method 2: Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube) (40 CFR 60 Appendix A).

The average gas velocity in a stack is determined from the gas density and from measurement of the average velocity head with a Type S (Stausscheibe or reverse type) Pitot tube. This method was used in its entirety as per the procedures outlined in Method 2.

ESCI performed a cyclonic flow check and velocity traverse using an S-type Pitot tube in each duct prior to the first test run. These results were used to calculate EtO mass flow rates. ESCI also used a standard Pitot tube constructed in accordance with Method 2C to measure velocity at a single point in the duct during the test runs to verify that gas flow rate remained steady during tests.

US EPA Method 3: Gas Analysis for the Determination of Dry Molecular Weight (40 CFR 60 Appendix A)

The Construction permit at 6(b) specifies testing using Method 3A or 3B (for calculating the dry molecular weight of the duct gases based on measurement of the duct gas oxygen and carbon dioxide concentrations). In accordance with Method 2, Section 8.6 and the approved Test Protocol, a dry molecular weight of 29.0 was assumed instead of by calculation. This is in accordance with Method 2 and is allowed by Method 3 because the process does not involve combustion and emits essentially ambient air.

US EPA Method 4: Determination of Moisture Content in Stack Gases (40 CFR 60 Appendix A)

The moisture concentrations in the duct gases were calculated assuming saturated conditions based on the measured gas temperature, duct static pressure and barometric pressure, in accordance with Method 4(16.4). For calculations pertaining to this method, see Appendix D.

- Barometric pressure was determined using local meteorological data from the time and date of the actual testing. See Appendix F.

- Duct static pressure was determined using an inclined oil manometer.

- Duct gas temperature was determined using from a type K thermocouple and thermometer.

US EPA Method 18: Measurement of Gaseous Organic Compound Emissions by Gas Chromatography

The major organic component of the gas mixture, EtO is separated by gas chromatography (GC). Measurement of EtO concentrations across the inlet/outlet ducts are expected to be uniform due to extensive air mixing throughout the emission control system. During backvent operations, constituents of the streams entering and exiting the AAT System were analyzed at a single point by an SRI, Model 8610, portable GC, equipped with the following: dual, heated sample loops and injectors; dual columns; and dual detectors. A flame ionization detector (FID) was used to quantify inlet EtO emissions, and photoionization detector (PID) was used to quantify low-level EtO emissions at the emission control system outlet. The PID was equipped with a 11.7eV lamp. For chromatographic data associated with the use of this method, see Appendix E. The sample transport system is described in Section 5.4 of this report.

Samples were continuously extracted and analyzed at approximately one- to two-minute intervals, for a total of 12 to 13 samples, during each 15-minute test run.

5.2 VOLUMETRIC FLOW MEASUREMENT

Exhaust gas flow at the inlet and outlet of the AAT scrubber was determined by Method 2, using an S-type pitot tube and an inclined-oil manometer. Sampling ports were located in accordance with Method 1. The test ports were located far enough from any flow disturbances and velocity was measured at multiple points within the duct cross-section to permit accurate flow measurement. Equal-area traverse points for pre-test velocity traverses were selected in accordance with Method 1. Confirmation of the absence of cyclonic flow occurred prior to the commencement of the three test runs. Please see Appendices B and F for additional Method 1 related information.

Because of the short duration of the backvent operation, traversing the entire stack during each minute of test run was infeasible. With approval of IEPA and US EPA, an average differential pressure point was determined before the test, and that parameter was used to confirm flow during each minute while concentration samples were collected. Please see Appendix F for tables of this information collected in the field.

Temperature measurements were obtained from a type K thermocouple (FLIR EA10) and thermometer attached to the sampling probe. Exhaust gas composition was assumed to be air saturated with water vapor.

5.3 CONTROL EFFICIENCY AND MASS EMISSIONS MEASUREMENT

During backvent operations, constituents of the streams entering and exiting the AAT System were analyzed by an SRI, Model 8610, portable gas chromatograph (GC), equipped with the following: dual, heated sample loops and injectors; dual columns; and dual detectors. A flame ionization detector (FID) was used to quantify inlet EtO emissions, and photoionization detector (PID) was used to quantify low-level EtO emissions at the emission control system outlet. The PID was equipped with an 11.7eV lamp. The mass of EtO in the inlet and outlet streams were determined using equation shown below in Section 5.9. EtO mass control efficiency during the backvent process was calculated by comparing the mass of EtO

vented to the system inlet to the mass of EtO vented from the system outlet. See equation shown in Section 5.9.

5.4 SAMPLE TRANSPORT

The Willowbrook II facility utilizes a dual stage AAT system equipped with a 10,150 cfm rated blower system that serves to quickly draw process emissions from the sources through the control system. The AAT Scrubber system efficiency operates at a very high level in large part due to the use of sulfuric acid in the scrubber liquor, which lowers the pH of the solution and acts as a catalyst - increasing the speed of the hydrolysis of ethylene oxide to ethylene glycol.

The gas sample was continuously pumped to the GC at approximately 1000 cubic centimeters per minute (cc/min) from the sample probe through two 100-foot lengths of heated and insulated 3/8" Teflon® sample line (.030 wall), each with an interior volume of approximately 1535 cubic centimeters. The source gas was pumped to the GC with a response time of approximately 1.5 seconds. See Appendix H for sample line volume and residence time calculations.

The lines were heated to $\geq$ 110 °C. Temperature of the heated lines was monitored before, during and after each trial run via observing the temperature on the heated lines temperature controller. See Appendix A for this data. The sample probe was constructed of stainless steel tubing and was not heated.

At the inlet of the Safe Cell System, the sampling ports were located in the duct immediately upstream of the packed tower scrubber. At the outlet of the AAT System, sampling ports were located in the exhaust stack downstream of the dry bed reactors. See Appendix B for sampling port location information.

5.5 GC INJECTION

Source-gas samples were then injected into the GC which was equipped with two heated sampling loops, each containing a volume of approximately 2 cubic centimeters (cc) and maintained at 100 degrees Celsius (°C). Injections occurred at approximately one to two-minute intervals during backvent testing. Helium was the carrier gas for both the FID and the PID.

5.6 GC CONDITIONS

The packed columns for the GC were both operated at 90 °C. The columns were stainless steel, 6 feet long, 0.125 inch outer diameter, packed with 1 percent SP-1000 on 60/80 mesh Carbopack B.

During the analysis, the FID was operated at 250 °C. The support gases for the FID were hydrogen (99.995% pure) and air (99.9999% pure). Any unused sample gas was vented from the GC system back to the inlet of the control device being tested.

5.7 CALIBRATION STANDARDS

The FID was calibrated for mid-range part-per-million-by-volume (ppmv) level analysis using gas proportions similar to the following:

1) 1000 ppmv EtO, balance nitrogen ***
2) 100 ppmv EtO, balance nitrogen
3) 50 ppmv EtO, balance nitrogen (audit gas)
4) 10 ppmv EtO, balance nitrogen
5) 1 ppmv EtO, balance nitrogen

***Note: Calibrations for this standard were performed following the test to confirm appropriate range of instrument.

The PID was calibrated for low-range ppmv level analyses using gas proportions similar to the following:

1) 100 ppmv EtO, balance nitrogen
2) 50 ppmv EtO, balance nitrogen (audit gas)
3) 10 ppmv EtO, balance nitrogen
4) 1 ppmv EtO, balance nitrogen

See Appendix J for calibration gas certifications. Please see Appendix I for triplicate calibration data performed before and after each set of test runs and calibration curves.

As a part of the test's quality assurance, limit of detection and recovery studies were performed. Refer to that section later in the document and Appendices K and I, respectively for further information.

5.8 SAMPLING DURATION

Testing was performed in 15-minute increments in conjunction with normal production operations, for each of the three test runs while chamber backvents were operating.

5.9 SAMPLE CALCULATIONS

Method 1

Equivalent diameter was calculated as follows:

$$D_e = \frac{2(L)(W)}{L+W}$$

Actual diameters of round ducts and equivalent diameters of square and rectangular ducts were used to evaluate whether sufficient distance existed between the sample ports and upstream and downstream flow disturbances. These figures were used in conjunction with Method 1's Table 1.1 and 1.2 to ensure that the minimum number of traverse points required for testing was exceeded.

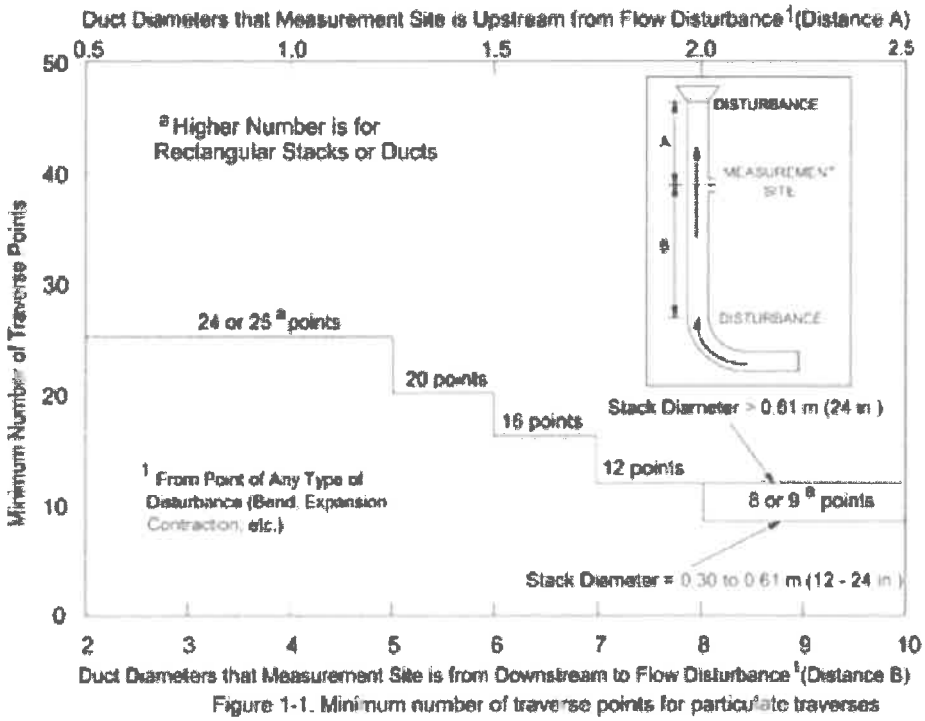


Figure 1-1. Minimum number of traverse points for particulate traverses

* * * * *

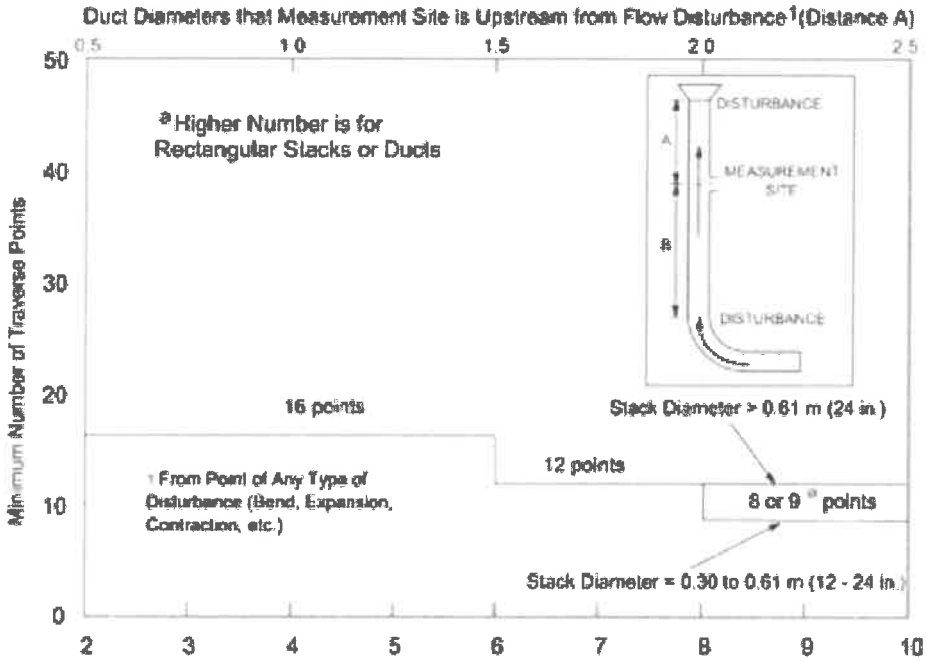


Figure 1-2. Minimum number of traverse points for velocity (nonparticulate) traverses

Method 2

Stack gas velocity and volumetric flow rate were calculated using equation 2-7 and 2-8 as outlined in Method 2.

Q = Average Stack Gas Dry Volumetric Flow Rate (dscf/min)

$$= 60\,(1 - B_{ws})\,V_s\,A \left| \frac{T_{std}\,P_s}{T_{s(abavg)}\,P_{std}} \right|$$

V_s = Average Stack Gas Velocity

$$V_s = K_p\,C_p \left[\frac{\sum_{i=1}^{n} \sqrt{\Delta p_i}}{n} \right] \sqrt{\frac{T_{s(abavg)}}{P_s\,M_s}}$$

Where:

K_p = Velocity equation constant

$$= 85.49 \frac{ft}{\sec} \left[\frac{(lb/lb-mole)(in.\,Hg)}{(^{\circ}R)(in.\,H_2O)} \right]^{1/2}$$

C_p = Pitot Tube Coefficient = 0.84 (S-type pitot tube coefficient for geometric calibration)

Δp_i = Individual velocity head reading at traverse point "i" (in. Hg)

n = number of traverse points

$T_{s(abavg)}$ = Average absolute stack temperature (°R)

P_s = Absolute stack pressure ($P_{bar} + P_g$)

P_{bar} = Barometric pressure at measurement site (in. Hg)

P_g = Stack static pressure (in. Hg)

M_s = Molecular weight of stack gas, wet basis

$$M_s = M_d\,(1 - B_{ws}) + 18.0 B_{ws}$$

Method 4

Moisture content was determined using the calculation for saturation in accordance with Method 4.

$$B_{ws(svp)}(\%) = 100\left(\frac{10^{\left(6.691-\left(\frac{3144}{T_{s\,(avg)}+390.86}\right)\right)}}{\left(P_b+\frac{P_{static}}{13.6}\right)}\right)$$

Where:

$B_{ws(svp)}(\%)$ = Saturated moisture concentration (% by volume)

$T_{s(abavg)}$ = Average absolute stack temperature (°F)

P_b = Barometric pressure at measurement site (in. Hg)

P_{static} = Stack static pressure (in. H_20)

Mass Emission Calculation

Mass emissions of EtO during backvent were calculated using the following equation:

$$W = (Q)(MolWt)(C/10^6)/(MolVol)$$

Where:

W	=	EtO mass flow rate, pounds per minute
Q	=	Corrected duct gas volumetric flow rate, dry standard cubic feet per minute at 68 degrees F and 29.92 in. Hg (see calculation under Method 2)
MolWt	=	44.05 pounds EtO per pound mole
C	=	EtO concentration, parts per million by volume
10^6	=	Conversion factor, ppmv per "cubic foot per cubic foot"
MolVol	=	385.32 cubic feet per pound mole at 68 degrees F and 29.92 in. Hg

Control Efficiency Calculation

Mass control efficiency of EtO during backvent was calculated using the following equation:

$$Efficiency = (W_i - W_o / W_i)(100)$$

Where:

W_i = Mass flow rate to the control device inlet, pounds per minute, calculated as described above where:

C_i = EtO concentration at the control device inlet, ppm

Q_i = Duct gas volumetric flow rate at the control device inlet, dry standard cubic feet per minute

W_o = Mass flow rate from the control device outlet, pounds per minute calculated as described above where:

C_o = EtO concentration at the control device outlet, ppm

Q_o = Duct gas volumetric flow rate at the control device outlet, dry standard cubic feet per minute

Correction to Dry Basis

Dry basis concentration = (wet basis concentration) / (1-w)

where:

w = fraction of emitted exhaust gas, by volume, which is water vapor.

Results of the control-efficiency testing are presented in Section 8.0 and in Table 1 and 2.

6.0 TEST SCENARIO

Backvent testing was performed during normal process load conditions, with freshly sterilized product in the sterilization chambers. Three test runs were conducted in series to verify the performance of the emission-control system.

Sterigenics scheduled three chambers to end the sterilization cycle to allow for the three test runs to run consecutively. The general testing sequence was as follows:

Timing	Task	Method
Prior to test	Sample locations established	Method 1
Prior to test	Sample traverse locations established	Method 1
One time prior to each set of runs	3-point calibration performed in triplicate.	Method 18
One time prior to each set of runs	Confirm absence of cyclonic flow	Method 1
One time prior to each set of runs	Collect AAT system scrubber liquor pH, tank level, and glycol % information. Note levels present from aeration.	N/A
One time prior to each set of runs	Flow traverse of inlet and outlet conducted to establish flow rate and measurement centroid	Method 2
Prior to each test run	Note temperature reading of heated lines	N/A
Over test duration	Chamber door opened approximately 12 inches, actuator switch activates backvent	N/A
Beginning of each run	First sample initiated	Method 18
Over test duration	Samples at inlet and outlet taken approximately every 1-minute for a total of 15-minutes	Method 18
Over test duration	Flow monitoring sampled approximately every 1-minute.	Method 2
Mid-Test	Note temperature reading of heated lines	Method 18
After each test run	Collect cycle number and ending backvent EtO concentration in chamber head space are noted	N/A
After each test run	Note temperature reading of heated lines	Method 18
After each test run	Conduct recovery study	Method 18
After conclusion of each set of test runs	Perform post calibration checks	Method 18
After conclusion of each set of test runs	Collect AAT system scrubber liquor pH, tank level, and glycol %.	N/A
One time following each set of runs	Obtain meteorological data for sampling time	N/A
At least once during two test days for WB I and WB II	Perform Limit of Detection Study	Method 18

7.0 QA/QC

7.1 FIELD TESTING QUALITY ASSURANCE

At the beginning of the test, the sampling system was leak checked at a vacuum of 15 inches of mercury. The sampling system was considered leak free when the flow indicated by the rotameters fell to zero.

At the beginning of the test, a system blank was analyzed to ensure that the sampling system was free of EtO. Ambient air was introduced at the end of the heated sampling line and drawn through the sampling system line to the GC for analysis. The resulting chromatogram also provided a background level for non-EtO components (i.e. ambient air, carbon dioxide, water vapor) which are present in the source gas stream due to the ambient dilution air which is drawn into the emission-control device, and due to the destruction of EtO by the emission-control device which produces carbon dioxide and water vapor. This chromatogram, designated ambient background, is included with the calibration data in Appendix I.

A recovery study was also performed in accordance with Section 8.4.1 of Method 18 using 10 ppm and 100 ppm EtO calibration gas. The 100 ppm calibration gas was drawn through the heated sample line used at the control device inlet, and the 10 ppm calibration gas was drawn through the heated sample line used at the control device outlet. The calibration procedure was repeated in this manner, and it was verified that the analyzer response was within 10% of the calibration gas concentration sampled. See calibration data in Appendix I for further information regarding the recovery study.

7.2 CALIBRATION PROCEDURES

The GC system was calibrated at the beginning and conclusion of each day's testing. Using the Peaksimple II analytical software, a calibration curve was constructed for each detector. Calibration data can be found in Appendix I.

A seven-point Method Detection Limit (MDL) or Limit of Detection (LOD) study was performed prior to testing using procedures described in Section 15.0 of US EPA Method 301 (40 CFR 63 Appendix A) and in 40 CFR 136 Appendix B. The study was recommended by OAQPS and accepted by IEPA. The LOD for this test was determined to be 0.10ppm. A recovery study was also performed in accordance with Section 8.4.1 of Method 18 using 10 ppm and 100 ppm EtO calibration gas. The 100 ppm calibration gas was

drawn through the heated sample line used at the control device inlet, and the 10 ppm calibration gas was drawn through the heated sample line used at the control device outlet. The calibration procedure was repeated in this manner, and it was verified that the analyzer response was within 10% of the calibration gas concentration sampled. Results of the LOD study are presented in Appendix K. Results of the recovery study are presented in Appendix I.

All calibration gases and support gases used were of the highest purity and quality available. A copy of the laboratory certification for each calibration gas is attached as Appendix J.

8.0 TEST RESULTS

The AAT Safe Cell System demonstrated an EtO control efficiency of greater than 99.51 percent. In accordance with various state and federal requirements, this control equipment must have an EtO control efficiency of 99 percent or more. The AAT Safe Cell System has met this requirement.

The test results are summarized in Tables 1 and 2. These tables include results for EtO control efficiency of the emission-control device. Sample calculations related to destruction efficiency and other calculations can be found in Section 5.9.

TABLES 1 AND 2

TABLE 1
ETHYLENE OXIDE CONTROL EFFICIENCY SUMMARY – BACKVENT
STERIGENICS - WILLOWBROOK, ILLINOIS (PLANT 2)
SEPTEMBER 20, 2018

Test Run	Inlet Average Concentration (ppm)	Inlet Average Mass Flow rate (lb/min)	Outlet Average Concentration (ppm)[1]	Outlet Average Mass Flow rate (lb/min) ≤	Control Efficiency ≥
1	37.98	0.03448	ND	0.00011	99.3677%
2	67.42	0.06097	ND	0.00011	99.4900%
3	53.21	0.04799	ND	0.00011	99.6590%

Control Efficiency ≥ 99.5056%

Efficiency = (MassFlowin - MassFlowout / MassFlowin)(100)
Mass Flow (lb/min) = (VolFlow)(MolWt)(C /10^{6})/(MolVol)

MW EtO = 44.05
MolVol = 385.32
C = Dry Concentration
[1] ND = Non Detect. Detection limit of the GC was determined to be 0.1 ppm

	INLET		OUTLET	
	Average Temperature (°F)	Moisture Content (%)	Average Temperature (°F)	Moisture Content (%)
Run 1	101.8	6.9834	101.8	6.9811
Run 2	103.1	7.2783	103.1	7.2607
Run3	104.1	7.4843	104.1	7.4811

TABLE 2 - ETHYLENE OXIDE CONTROL EFFICIENCY – BACKVENT
STERIGENICS - WILLOWBROOK, ILLINOIS (PLANT 2)
SEPTEMBER 20, 2018

		INLET ETO				OUTLET ETO				
Run #	Time	Wet Concentration (PPM)[1]	Dry Concentration (PPM)[1]	Dry Volumetric Flow	Mass Flow[3] (lb/min)	Wet Concentration (PPM)[1,2]	Dry Concentration (PPM)[1,2]	Dry Volumetric Flow	Mass Flow[3] (lb/min) ≤	Control Efficiency[4] ≥
1	1539	7.94	8.5	7940.8	0.00775	ND	ND	8943.3	0.0001099	98.5816%
1	1540	8.41	9.0	7940.8	0.00821	ND	ND	8943.3	0.0001099	98.6608%
1	1541	213.00	229.0	7940.8	0.20788	ND	ND	8943.3	0.0001099	99.9471%
1	1542	30.40	32.7	7940.8	0.02967	ND	ND	8943.3	0.0001099	99.6295%
1	1544	22.30	24.0	7940.8	0.02176	ND	ND	8943.3	0.0001099	99.4950%
1	1545	22.20	23.9	7940.8	0.02167	ND	ND	8943.3	0.0001099	99.4927%
1	1546	21.80	23.4	7940.8	0.02128	ND	ND	8943.3	0.0001099	99.4834%
1	1547	19.70	21.2	7940.8	0.01923	ND	ND	8943.3	0.0001099	99.4283%
1	1548	18.80	20.2	7940.8	0.01835	ND	ND	8943.3	0.0001099	99.4009%
1	1549	20.30	21.8	7940.8	0.01981	ND	ND	8943.3	0.0001099	99.4452%
1	1550	19.30	20.7	7940.8	0.01884	ND	ND	8943.3	0.0001099	99.4165%
1	1552	19.80	21.3	7940.8	0.01932	ND	ND	8943.3	0.0001099	99.4312%
2	1617	13.00	14.0	7910.4	0.01268	ND	ND	8910.8	0.0001098	99.1336%
2	1618	545.00	587.8	7910.4	0.53154	ND	ND	8910.8	0.0001098	99.9793%
2	1619	50.00	53.9	7910.4	0.04877	ND	ND	8910.8	0.0001098	99.7747%
2	1620	22.00	23.7	7910.4	0.02146	ND	ND	8910.8	0.0001098	99.4881%
2	1621	22.80	24.6	7910.4	0.02224	ND	ND	8910.8	0.0001098	99.5060%
2	1622	19.70	21.2	7910.4	0.01921	ND	ND	8910.8	0.0001098	99.4283%
2	1623	20.00	21.6	7910.4	0.01951	ND	ND	8910.8	0.0001098	99.4369%
2	1625	20.50	22.1	7910.4	0.01999	ND	ND	8910.8	0.0001098	99.4506%
2	1626	19.80	21.4	7910.4	0.01931	ND	ND	8910.8	0.0001098	99.4312%
2	1627	19.50	21.0	7910.4	0.01902	ND	ND	8910.8	0.0001098	99.4224%
2	1628	21.30	23.0	7910.4	0.02077	ND	ND	8910.8	0.0001098	99.4712%
2	1629	19.40	20.9	7910.4	0.01892	ND	ND	8910.8	0.0001098	99.4195%
2	1630	19.70	21.2	7910.4	0.01921	ND	ND	8910.8	0.0001098	99.4283%
3	1651	20.60	22.3	7889.3	0.02008	ND	ND	8885.5	0.0001098	99.4533%
3	1652	246.00	265.9	7889.3	0.23982	ND	ND	8885.5	0.0001098	99.9542%
3	1653	40.10	43.3	7889.3	0.03909	ND	ND	8885.5	0.0001098	99.7191%
3	1654	34.20	37.0	7889.3	0.03334	ND	ND	8885.5	0.0001098	99.6707%
3	1655	30.80	33.3	7889.3	0.03003	ND	ND	8885.5	0.0001098	99.6343%
3	1657	31.60	34.2	7889.3	0.03081	ND	ND	8885.5	0.0001098	99.6436%
3	1658	33.10	35.8	7889.3	0.03227	ND	ND	8885.5	0.0001098	99.6597%
3	1659	31.50	34.0	7889.3	0.03071	ND	ND	8885.5	0.0001098	99.6425%
3	1700	31.80	34.4	7889.3	0.03100	ND	ND	8885.5	0.0001098	99.6458%
3	1701	29.40	31.8	7889.3	0.02866	ND	ND	8885.5	0.0001098	99.6169%
3	1703	31.50	34.0	7889.3	0.03071	ND	ND	8885.5	0.0001098	99.6425%
3	1704	30.10	32.5	7889.3	0.02934	ND	ND	8885.5	0.0001098	99.6258%

Notes:

[1] PPM = parts per million by volume

[2] ND = Non detect. Detection limit of the GC was determined to be 0.10 ppm.

[3] See Table 1 for Mass Flow Calculation

[4] See Table 1 for control efficiency calculation

Efficiency = (MassFlowin - MassFlowout / MassFlowin)(100)

Flow (lb/min) = (VolFlow)(MolWt)(C /10^{6})/(MolVol)

APPENDICES

APPENDIX A

Process Parameter Logs

ECSi

PROCESS PARAMETER LOG FOR EACH TRIAL

DATE: 20 SEP 2018

SITE AAT TESTED (circle one): Willowbrook I (Willowbrook II)

Chamber Backvent Tested:	J – 13 pallet chamber w/ 10 pallets	
Chamber Running Cycle Number:	829	
Parameter	START (Data and Time)	FINISH (Data and Time)
Backvent Opening Time	4:50 pm	5:05
Levels From Aeration	not recorded	not recorded
Ending Chamber EO Concentration	480 ppm EO	

	Beginning (Time)	Middle (Time)	End (Time)
Heated Lines Temp Check Include Temp Units	230 F / 230 F	230 F / 230 F	230 F / 230 F
	4:50 pm	4:57 pm	5205 pm

PROCESS PARAMETER LOG FOR EACH TRIAL

DATE: 20 SEP 2018

SITE AAT TESTED (circle one): Willowbrook I Willowbrook II

Chamber Backvent Tested:	K – 13 pallet chamber w/ 10 pallets	
Chamber Running Cycle Number:	829	
Parameter	START (Data and Time)	FINISH (Data and Time)
Backvent Opening Time	4:16 pm	4:31
Levels From Aeration	not collected	not collected
Ending Chamber EO Concentration	6900 ppm EO	

	Beginning (Time)	Middle (Time)	End (Time)
Heated Lines Temp Check Include Temp Units	230 F / 231 F 4:15 pm	230 F / 230 F 4:23 pm	230 °F / 230 °F 4:32

PROCESS PARAMETER LOG FOR EACH TRIAL

DATE: 20 SEP 2018

SITE AAT TESTED (circle one): Willowbrook I (Willowbrook II)

Chamber Backvent Tested:	G – 13 pallet chamber W/ 10 pallets	
Chamber Running Cycle Number:	829	
Parameter	START (Data and Time)	FINISH (Data and Time)
Backvent Opening Time	3:38 pm	3:53 pm
Levels From Aeration	8.3 ppm 3:07 pm (inlet) 10.6 3:13 pm	not taken
Ending Chamber EO Concentration	600 ppm EO	

	Beginning (Time)	Middle (Time)	End (Time)
Heated Lines Temp Check Include Temp Units	230 F/230 F 3:07 pm	230 F/230 F 3:50 pm	230 F/230 F 3:53 pm

PROCESS PARAMETER LOG FOR EACH SET OF TRIALS

Circle One: Willowbrook 1 AAT (Willowbrook 2 AAT)

Parameter	BEFORE (Time) 1230 PM	AFTER (Time) 1715 (0515 PM)
AAT Tank Level (inches)	193" NZ 20SEP18	193" NZ 20SEP18
AAT Liquor pH	0.77 NZ 20SEP18	0.78 NZ 20SEP18
AAT Liquor Glycol %	43.2 % NZ 20SEP18	43.4 % NZ 20SEP18

Samples collected by: NICK ZIELINSKI

Signature: [signature]

DATE: 20SEP18

PLEASE ATTACH TODAY'S METEOROLOGICAL DATA TO THESE TEST RECORDS

APPENDIX B

Method 1 Calculation

ECSi

WB Sample Port Locations	Duct Size/Configuration	Length (Diameter)	Width	Diameter (Eq. Diameter)		Distance from/to Disturbance	Diameters from/to Disturbance	2D or greater downstream?	0.5D or greater upstream?
WB I Inlet	36" round	36		36	Downstream	78	2.2	YES	
				36	Upstream	44	1.2		YES
WB I Outlet	30" x 20" rectangular	30	20	24	Downstream	60	2.5	YES	
				24	Upstream	84	3.5		YES
WB II Inlet	28" round	28		28	Downstream	108	3.9	YES	
				28	Upstream	96	3.4		YES
WB II Outlet	28" square	28	28	28	Downstream	56	2.0	YES	
				28	Upstream	170	6.1		YES

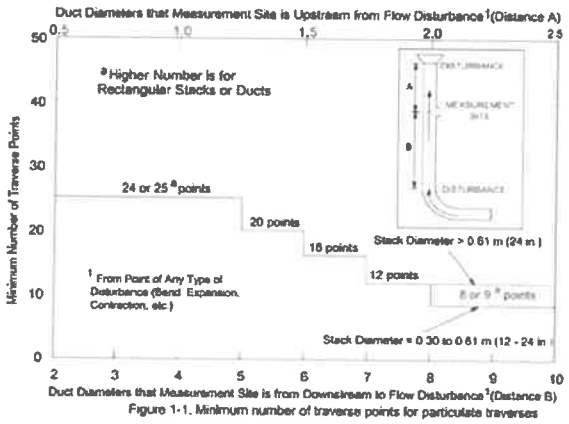


Figure 1-1. Minimum number of traverse points for particulate traverses

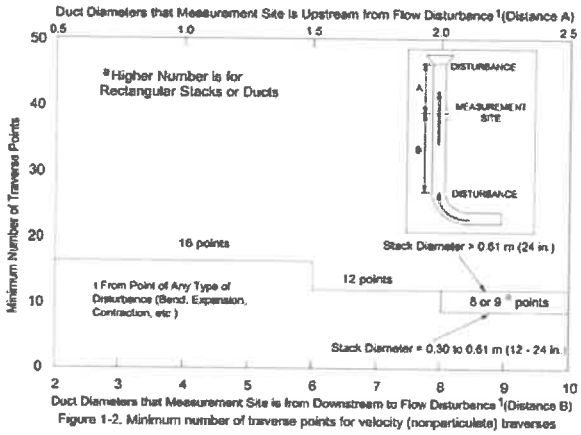
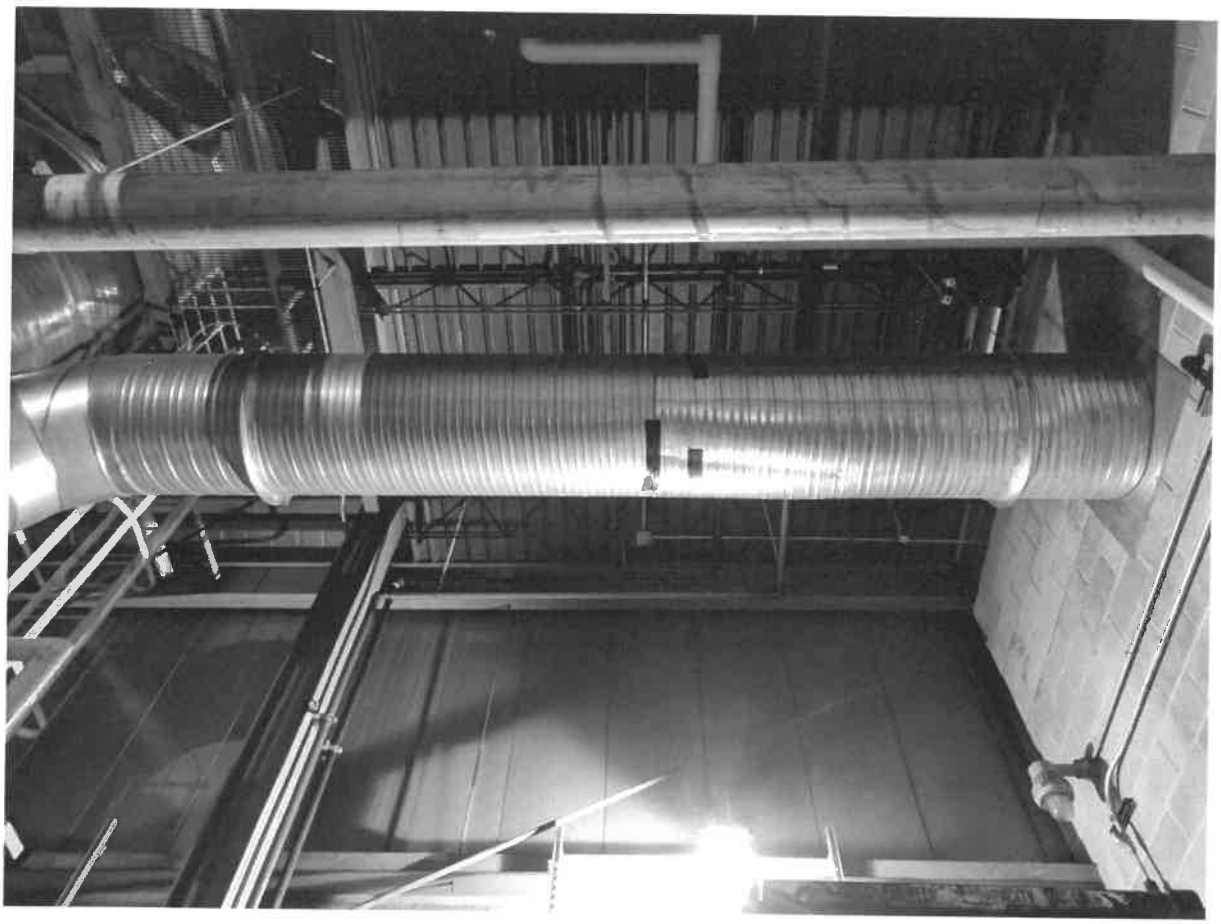


Figure 1-2. Minimum number of traverse points for velocity (nonparticulate) traverses

$$D_e = \frac{2(L)(W)}{L+W}$$

Willowbrook II AAT Inlet Duct Sampling Location

Photo Description – Photo taken in WB2 AAT Room, looking towards roof near room entrance. North is towards bottom of photo, and AAT control device is to the left.



Willowbrook II Inlet Duct Sampling Duct Location Diagram

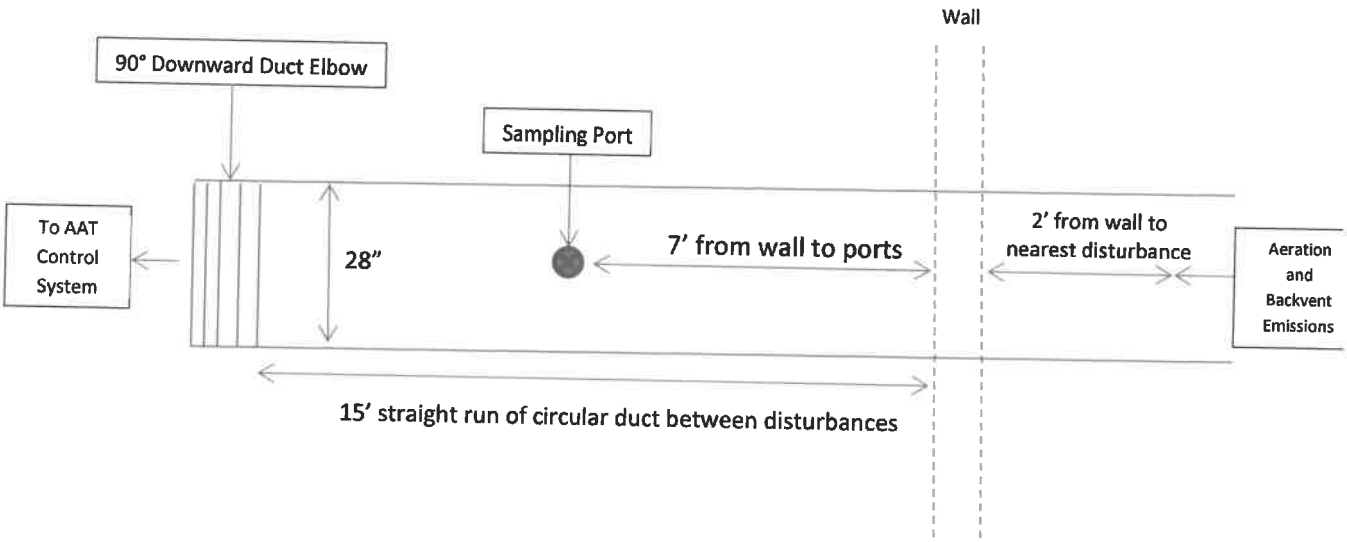
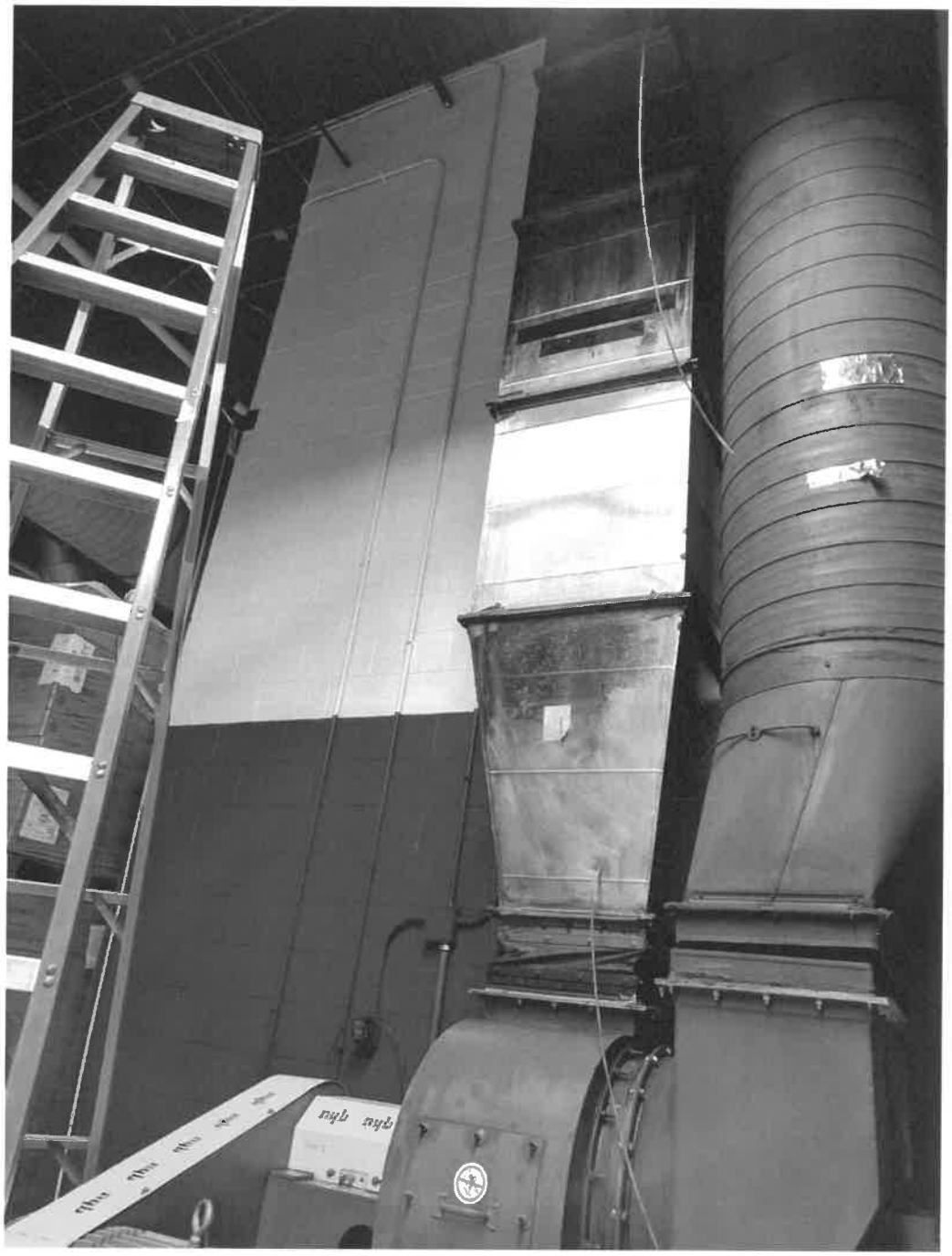


Diagram Description – Diagram depicts inlet duct configuration seen in photo, looking upward towards roof. All ducting in diagram has a 28" circular diameter. Sampling port depicted faces AAT Scrubber Room floor. An additional port will be located on the duct 90° from depicted port.

Willowbrook 2 AAT Outlet Duct Sampling Location

Photo Description – Photo taken in WB2 AAT Drybed Room, looking Southeast. Duct is square until it transitions near the roofline. Each pictured segment of straight duct is 34" in length.



Willowbrook II Outlet Sampling Duct Location Diagram

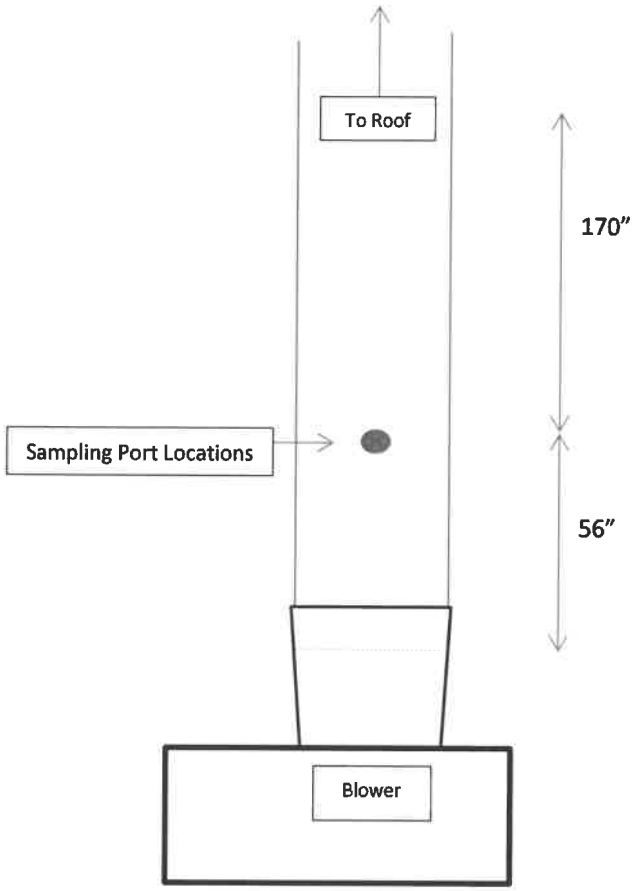


Diagram Description – Diagram depicts outlet duct sampling configuration in AAT Drybed Room seen in photo, with a slightly more perpendicular view to the duct, towards the south. The main run of ducting where the samples will be obtained is a 28" square duct. 56" and 170" are measurements to nearest duct disturbances.

APPENDIX C

Method 2 Calculation

ECSi

ECSi, Inc.

Volumetric Flow Calculation - AAT Inlet

Sterigenics US, LLC - Willowbrook, IL (Plant 2)
9/20/2018

Data from Traverse Table			Constants		
Average SQRT(Δp)	0.6119	from Traverse Table	**MW dry =**	29.00	
Temp	94.9	°F	**stack diameter =**	28	in.
	555	°R	**stack area =**	4.28	sq. ft.
			Tstd =	528	
			Pstd =	29.92	
Moisture Content	5.68%		**Cp =**	0.84	
Ms	28.38	molecular weight of stack gas	**Kp =**	85.49	
Pb	29.15	Barometric pressure			
Pg	-0.35	Stack static pressure			
Ps	29.12	Absolute stack pressure			

Stack Velocity (Vs) = 36.0 ft/sec

$$V_s = K_p \, C_p \left[\frac{\sum_{i=1}^{n} \sqrt{\Delta \, p_i}}{n} \right] \sqrt{\frac{T_{s\,(abavg)}}{P_s \; M_s}}$$

Stack Flow (inlet)= **9239** **acf/min**

$Q_{actual} = 60 * V_s * A_s$

Stack Flow (inlet) = **8071** **dscfm**

$$Q = 60\,(1 - B_{ws})\,V_s\,A \left| \frac{T_{std}\,P_s}{T_{s(abavg)}\,P_{std}} \right|$$

ECSi, Inc.

Volumetric Flow Calculation - AAT Outlet

Sterigenics US, LLC. - Willowbrook, IL (Plant 2)
9/20/2018

Data from Traverse Table			Constants		
Average SQRT(Δp)	0.5421	from Traverse Table	**MW dry =**	29.00	
			stack ID =	28x28	in.
Temp	101.7	°F	**stack area =**	5.44	sq. ft.
	562	°R	**Tstd =**	528	
			Pstd =	29.92	
Moisture Content	7.03%		**Cp =**	0.84	
Ms	28.23	molecular weight of stack gas	**Kp =**	85.49	
Pb	29.15	Barometric pressure			
Pg	0.1	Stack static pressure			
Ps	29.16	Absolute stack pressure			

Stack Velocity (Vs) = 32.2 ft/sec

$$V_s = K_p \, C_p \left[\frac{\sum_{i=1}^{n} \sqrt{\Delta \, p_i}}{n} \right] \sqrt{\frac{T_{s\,(abavg)}}{P_s \; M_s}}$$

Stack Flow (outlet)= **10506** **acf/min**

$$Q_{actual} = 60 * V_s * A_s$$

Stack Flow (outlet) = **8947** **dscfm**

$$Q = 60\,(1 - B_{WS})\,V_s\,A \left| \frac{T_{std}\,P_s}{T_{s(abavg)}\,P_{std}} \right|$$

ECSI, INC. - VELOCITY TRAVERSE DATA

Client: Sterigenics | Run #: 1 | Date: 9/20/2018 | Port Sketch:

Location: Willowbrook - Plant 2 | Probe Type: S | Baro Press: 29.15

Source: AAT Safe Cell System Inlet | Stack I.D.: 28 in.

	Port 1							Port 2						
Inches From Port	Point#	Delta P Low	Delta P High	Delta P Average	Delta P Sq Root	Stack Temp (F)	Cyclonic Angle	Point#	Delta P Low	Delta P High	Delta P Average	Delta P Sq Root	Stack Temp (F)	Cyclonic Angle
0.5	1	0.4	0.4	0.4	0.6325	88.2	7.2	1	0.5	0.5	0.5	0.7071	90.4	4.7
1.9	2	0.25	0.25	0.25	0.5000	88.2	6.3	2	0.25	0.25	0.25	0.5000	89.9	5.4
3.3	3	0.2	0.2	0.2	0.4472	88.5	3.4	3	0.3	0.3	0.3	0.5477	93.3	4.8
4.9	4	0.25	0.25	0.25	0.5000	91.2	4.8	4	0.35	0.35	0.35	0.5916	95.4	3.6
7.0	5	0.25	0.25	0.25	0.5000	93.5	3.6	5	0.4	0.4	0.4	0.6325	96.7	3.2
10.0	6	0.35	0.35	0.35	0.5916	95.8	4.7	6	0.45	0.45	0.45	0.6708	97.4	2.1
18.0	7	0.45	0.45	0.45	0.6708	95.6	3.8	7	0.45	0.45	0.45	0.6708	96.7	4.8
21.0	8	0.45	0.45	0.45	0.6708	95.7	3.7	8	0.47	0.47	0.47	0.6856	97.6	3.9
23.1	9	0.45	0.45	0.45	0.6708	97.4	5.1	9	0.4	0.45	0.425	0.6519	98.0	5.1
24.7	10	0.45	0.45	0.45	0.6708	97.9	4.5	10	0.45	0.45	0.45	0.6708	98.4	5.4
26.1	11	0.45	0.45	0.45	0.6708	98.2	3.6	11	0.48	0.48	0.48	0.6928	98.4	3.8
27.5	12	0.3	0.3	0.3	0.5477	97.4	2.2	12	0.35	0.35	0.35	0.5916	98.3	2.0
	13							13						
	14							14						
	15							15						
	16							16						
	17							17						
	18							18						
	19							19						
	20							20						
	21							21						
	22							22						
	23							23						
	24							24						
									Average Values:		0.3802	0.6119	94.9	4.2

ECSI, INC. - VELOCITY TRAVERSE DATA

Client: Sterigenics | Run #: 1 | Date: 9/20/2018 | Port Sketch:

Location: Willowbrook - Plant 2 | Probe Type: S | Baro Press: 29.15

Source: AAT Safe Cell System Outlet | Stack I.D.: 28x28

	Port 1 & 2							Port 3 & 4						
Inches From Port	Point#	Delta P Low	Delta P High	Delta P Average	Delta P Sq Root	Stack Temp (F)	Cyclonic Angle	Point#	Delta P Low	Delta P High	Delta P Average	Delta P Sq Root	Stack Temp (F)	Cyclonic Angle
3.5	1	0.5	0.5	0.5	0.7071	101	3.9	1	0.3	0.3	0.3	0.5477	100	4.4
7.0	2	0.55	0.55	0.55	0.7416	102	3.9	2	0.25	0.25	0.25	0.5000	102	5.4
10.5	3	0.6	0.6	0.6	0.7746	102	2.6	3	0.25	0.25	0.25	0.5000	102	5.6
14.0	4	0.6	0.6	0.6	0.7746	102	2.6	4	0.2	0.2	0.2	0.4472	102	3.1
17.5	5	0.55	0.55	0.55	0.7416	102	2.5	5	0.15	0.15	0.15	0.3873	102	1.8
21.0	6	0.6	0.6	0.6	0.7746	102	2.1	6	0.2	0.2	0.2	0.4472	102	2.5
24.5	7	0.6	0.6	0.6	0.7746	102	3.8	7	0.2	0.2	0.2	0.4472	102	2.0
3.5	1	0.4	0.4	0.4	0.6325	99.4	1.1	1	0.15	0.15	0.15	0.3873	101	4.2
7.0	2	0.4	0.4	0.4	0.6325	101	6.2	2	0.15	0.15	0.15	0.3873	102	5.0
10.5	3	0.4	0.4	0.4	0.6325	102	2.0	3	0.1	0.1	0.1	0.3162	102	1.2
14.0	4	0.3	0.3	0.3	0.5477	102	4.4	4	0.1	0.1	0.1	0.3162	102	4.7
17.5	5	0.3	0.3	0.3	0.5477	102	4.7	5	0.1	0.1	0.1	0.3162	102	1.8
21.0	6	0.4	0.4	0.4	0.6325	102	5.1	6	0.1	0.1	0.1	0.3162	102	0.8
24.5	7	0.4	0.4	0.4	0.6325	102	4.6	7	0.1	0.1	0.1	0.3162	102	2.5
Average Values:									0.3196			0.5421	101.7	3.4

APPENDIX D

Method 4 Calculation

ECSi

Sterigenics - Willowbrook 2 - AAT Inlet
9/20/2018

Saturate Moisture Content (%)

$$B_{ws(svp)}(\%) = 100\left(\frac{10^{\left(6.691-\left(\frac{3144}{T_{s(avg)}+390.86}\right)\right)}}{\left(P_b+\frac{P_{static}}{13.6}\right)}\right)$$

Ts	94.9	stack temperature (F)
Pb	29.15	barametreric pressure (in Hg)
ps	-0.35	static pressure of stack (in H2O)

Bws(svp) = 5.68 %

Sterigenics - Willowbrook 2 - AAT Outlet
9/20/2018

Saturate Moisture Content (%)

$$B_{ws(svp)}(\%) = 100\left(\frac{10^{\left(6.691-\left(\frac{3144}{T_{s(avg)}+390.86}\right)\right)}}{\left(P_b+\frac{P_{static}}{13.6}\right)}\right)$$

Ts	102	stack temperature (F)
Pb	29.15	barametreric pressure (in Hg)
ps	0.1	static pressure of stack (in H2O)

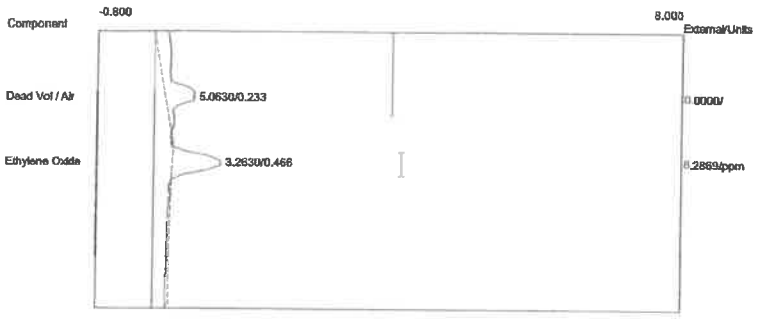
Bws(svp) = 7.03 %

APPENDIX E

Chromatograms - Backvent

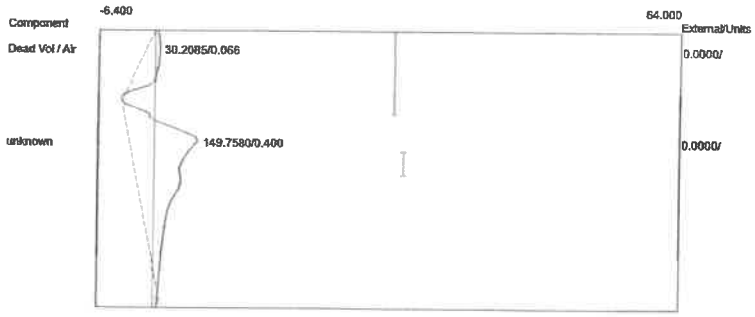
ECSi

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Aeration
Analysis date: 09/20/2018 15:09:28
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-A01.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



Component	Retention	Area	External	Units
Dead Vol / Air	0.233	5.0630	0.0000	
Ethylene Oxide	0.466	3.2630	8.2869	ppm
		8.3260	8.2869	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Aeration
Analysis date: 09/20/2018 15:11:37
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-A02.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer

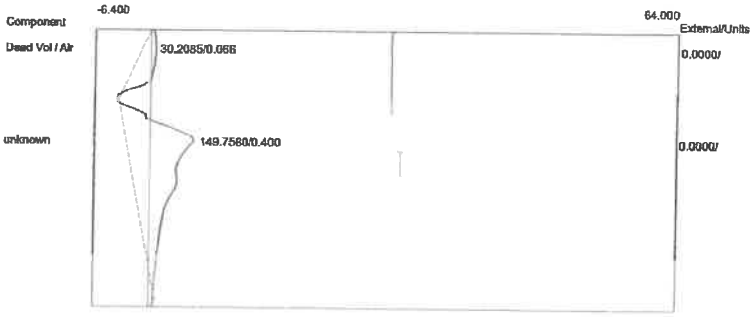


Component	Retention	Area	External	Units
Dead Vol / Air	0.066	30.2085	0.0000	
		30.2085	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Aeration
Analysis date: 09/20/2018 15:11:37
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-A02.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer

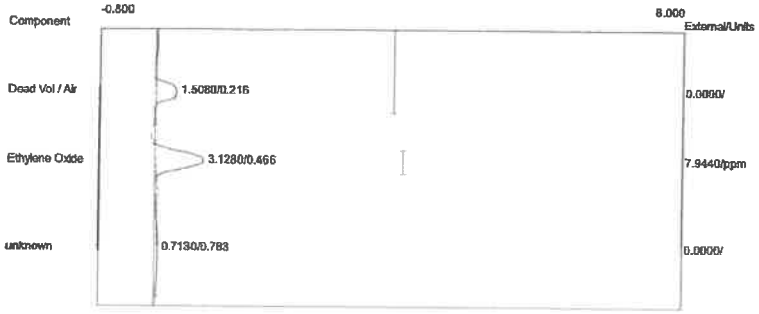
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.8040	0.0000	
Ethylene Oxide	0.483	4.1625	10.5713	ppm
		5.9665	10.5713	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Aeration
Analysis date: 09/20/2018 15:11:37
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-A02.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



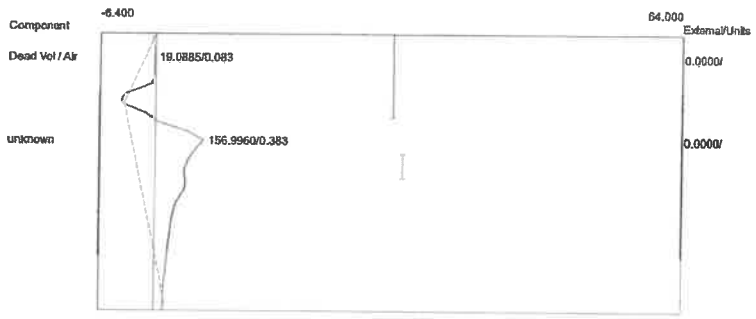
Component	Retention	Area	External	Units
Dead Vol / Air	0.066	30.2085	0.0000	
		30.2085	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:39:20
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-1B01.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



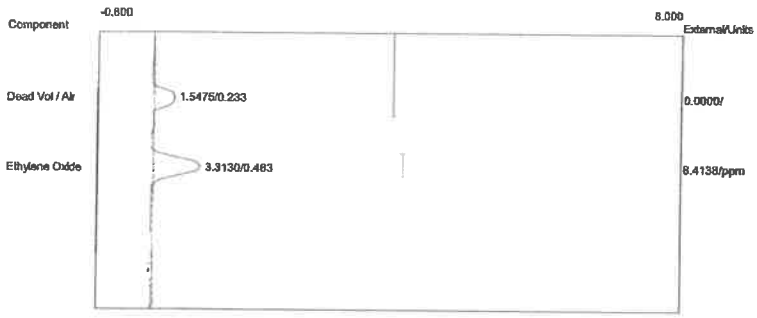
Component	Retention	Area	External	Units
Dead Vol / Air	0.216	1.5080	0.0000	
Ethylene Oxide	0.466	3.1280	7.9440	ppm
		4.6360	7.9440	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:39:20
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-1B01.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



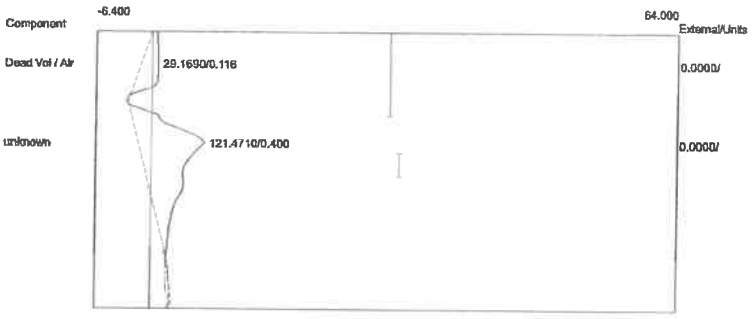
Component	Retention	Area	External	Units
Dead Vol / Air	0.083	19.0885	0.0000	
		19.0885	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:40:32
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-1B02.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



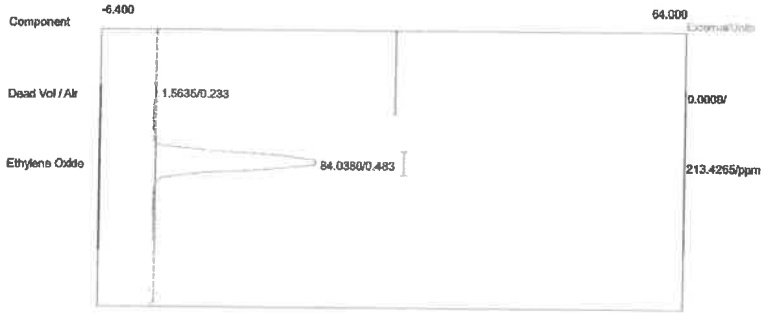
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.5475	0.0000	
Ethylene Oxide	0.483	3.3130	8.4138	ppm
		4.8605	8.4138	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:40:32
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-1B02.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



Component	Retention	Area	External	Units
Dead Vol / Air	0.116	29.1690	0.0000	
		29.1690	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:41:42
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-1B03.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer

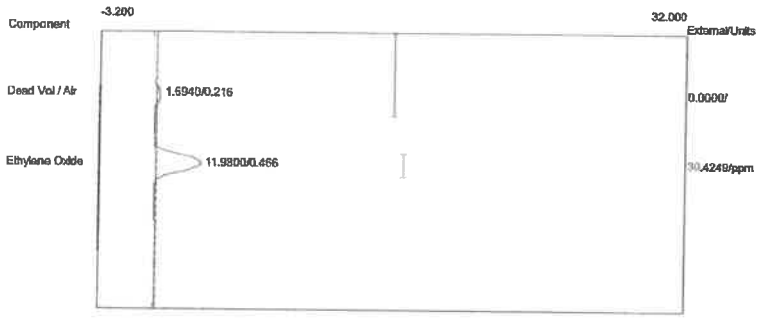


Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.5635	0.0000	
Ethylene Oxide	0.483	84.0380	213.4265	ppm
		85.6015	213.4265	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:41:42
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-1B03.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer

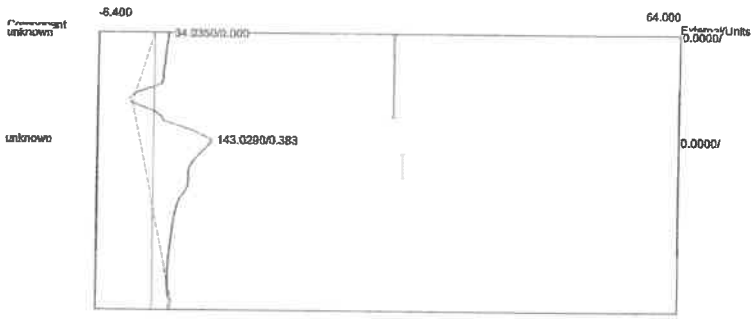
Component	Retention	Area	External	Units
		0.0000	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:42:51
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-1B04.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



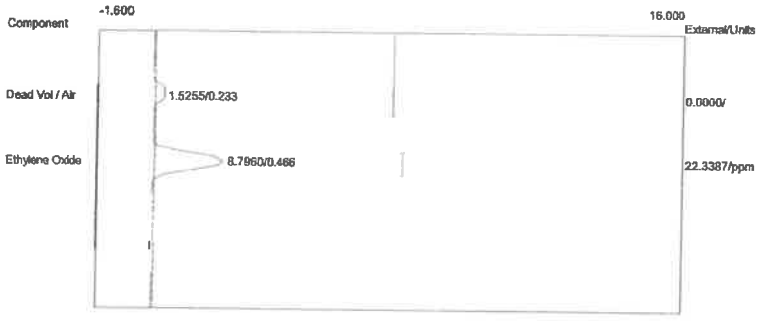
Component	Retention	Area	External	Units
Dead Vol / Air	0.216	1.6940	0.0000	
Ethylene Oxide	0.466	11.9800	30.4249	ppm
		13.6740	30.4249	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:42:51
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-1B04.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



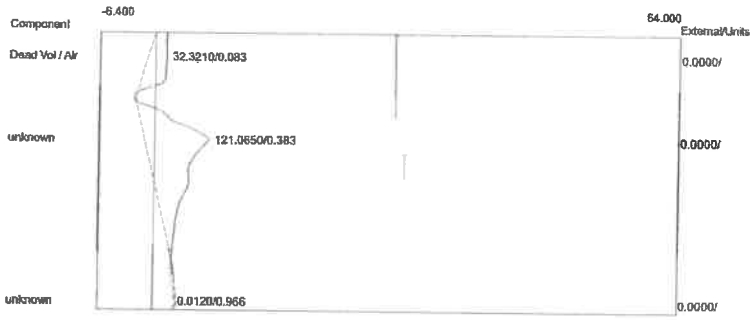
Component	Retention	Area	External	Units
		0.0000	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:44:03
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-1B05.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



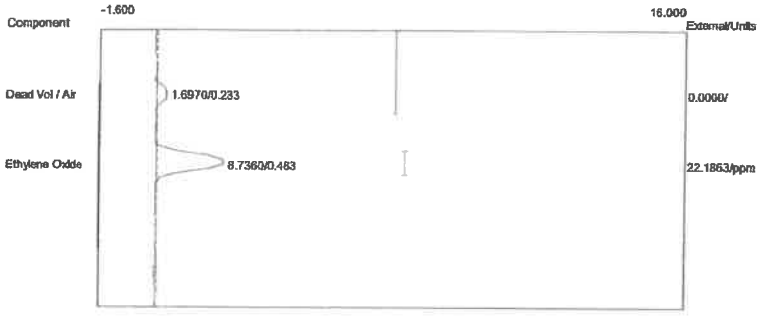
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.5255	0.0000	
Ethylene Oxide	0.466	8.7960	22.3387	ppm
		10.3215	22.3387	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:44:03
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-1B05.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



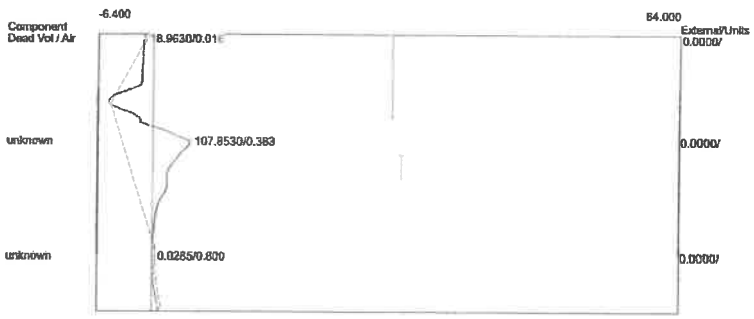
Component	Retention	Area	External	Units
Dead Vol / Air	0.083	32.3210	0.0000	
		32.3210	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:45:12
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-1B06.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



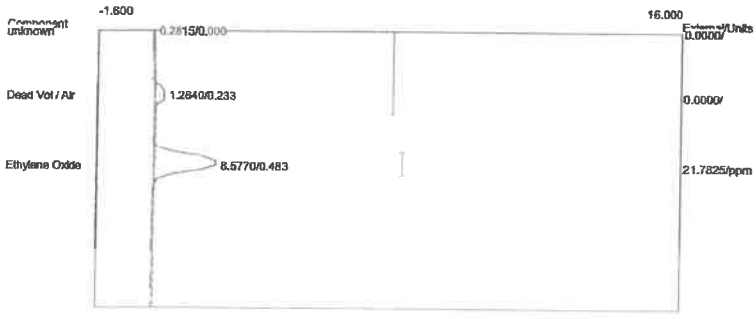
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.6970	0.0000	
Ethylene Oxide	0.483	8.7360	22.1863	ppm
		10.4330	22.1863	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:45:12
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-1B06.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



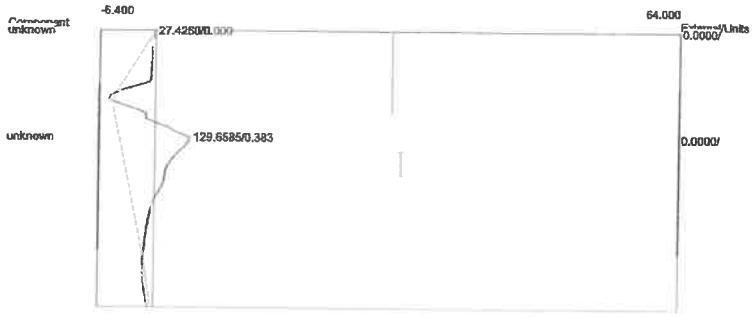
Component	Retention	Area	External	Units
Dead Vol / Air	0.016	18.9630	0.0000	
		18.9630	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:46:20
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-1B07.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



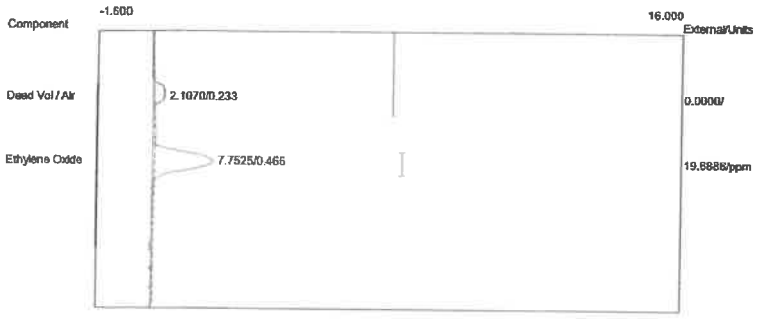
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.2640	0.0000	
Ethylene Oxide	0.483	8.5770	21.7825	ppm
		9.8410	21.7825	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:46:20
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-1B07.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



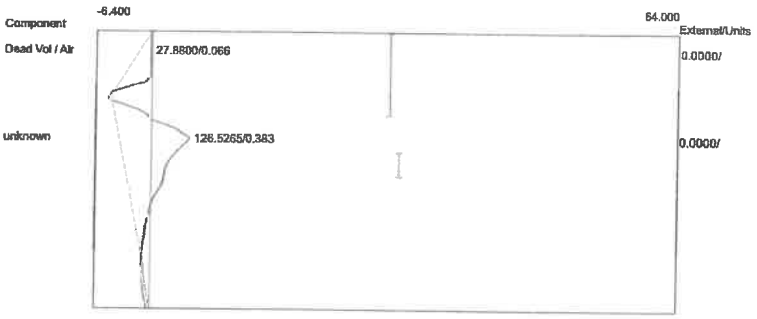
Component	Retention	Area	External	Units
		0.0000	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:47:29
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-1B08.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



Component	Retention	Area	External	Units
Dead Vol / Air	0.233	2.1070	0.0000	
Ethylene Oxide	0.466	7.7525	19.6886	ppm
		9.8595	19.6886	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:47:29
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-1B08.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



Component	Retention	Area	External	Units
Dead Vol / Air	0.066	27.8800	0.0000	
		27.8800	0.0000	

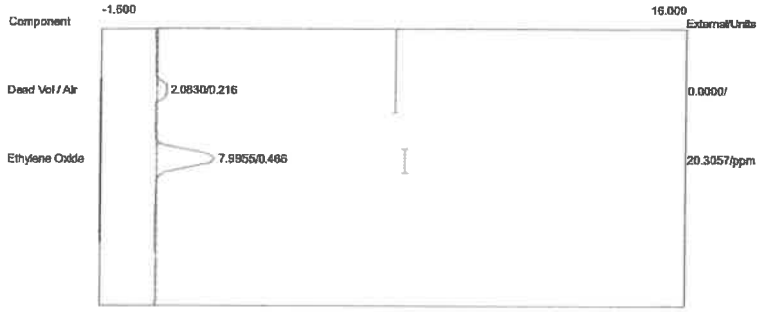
Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:48:40
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-1B09.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer

Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.8140	0.0000	
Ethylene Oxide	0.466	7.3910	18.7705	ppm
		9.2050	18.7705	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:48:40
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-1B09.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer

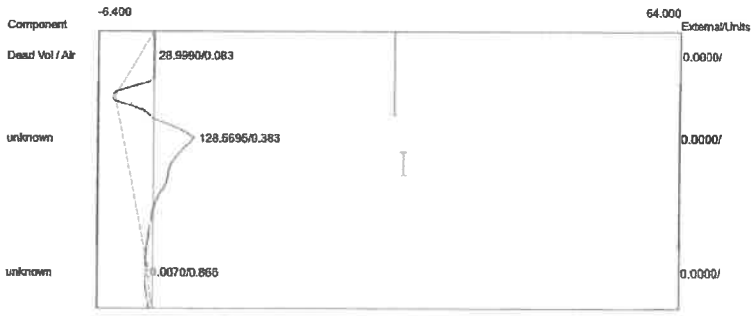
Component	Retention	Area	External	Units
Dead Vol / Air	0.066	26.4320	0.0000	
		26.4320	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:49:48
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-1B10.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



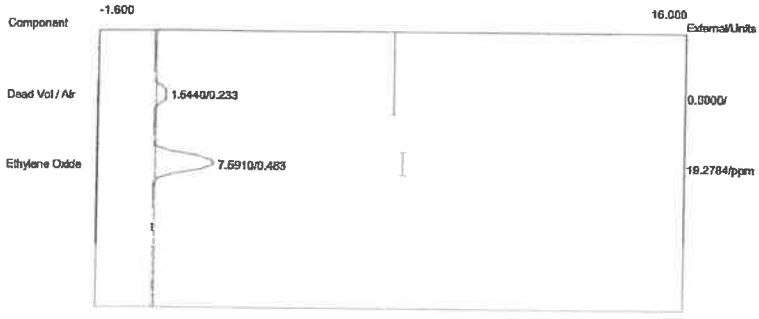
Component	Retention	Area	External	Units
Dead Vol / Air	0.216	2.0830	0.0000	
Ethylene Oxide	0.466	7.9955	20.3057	ppm
		10.0785	20.3057	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:49:48
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-1B10.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



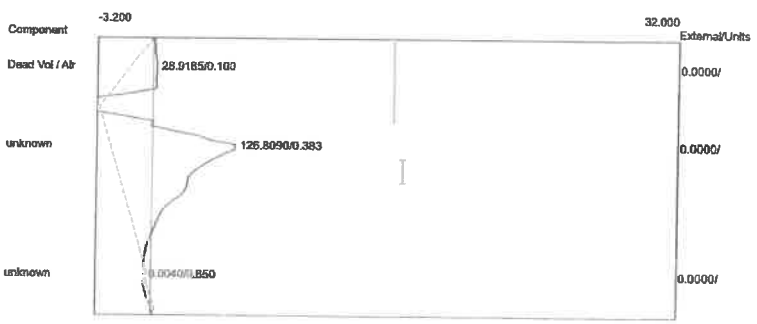
Component	Retention	Area	External	Units
Dead Vol / Air	0.083	28.9990	0.0000	
		28.9990	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:50:59
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-1B11.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



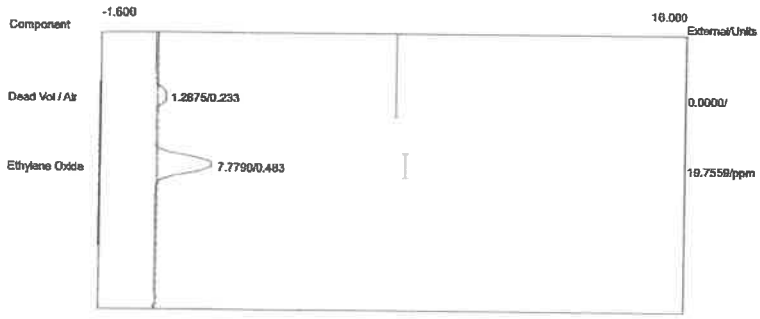
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.5440	0.0000	
Ethylene Oxide	0.483	7.5910	19.2784	ppm
		9.1350	19.2784	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:50:59
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-1B11.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



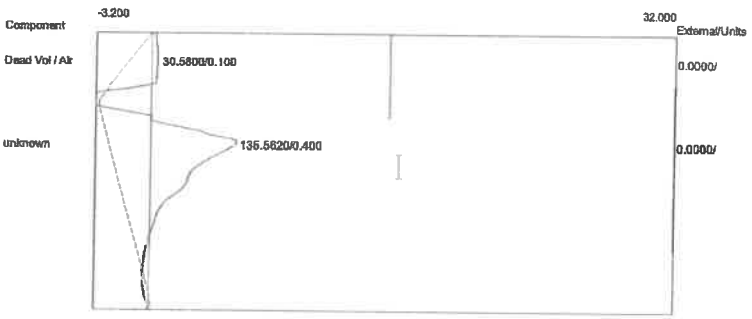
Component	Retention	Area	External	Units
Dead Vol / Air	0.100	28.9185	0.0000	
		28.9185	0.0000	

Lab name: ECSI
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:52:07
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-1B12.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



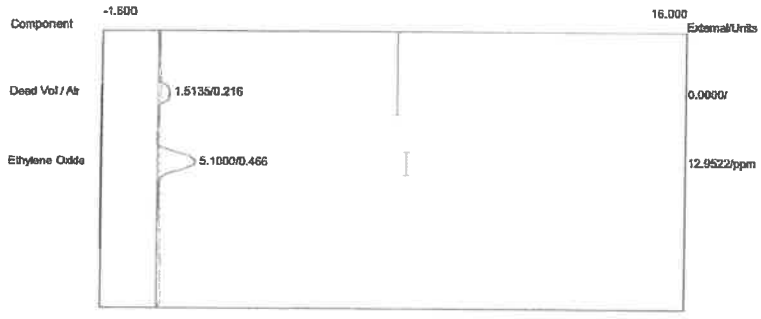
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.2875	0.0000	
Ethylene Oxide	0.483	7.7790	19.7559	ppm
		9.0665	19.7559	

Lab name: ECSI
Client: Sterigenics - Willowbrook 2
Client ID: Run#1BV
Analysis date: 09/20/2018 15:52:07
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-1B12.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



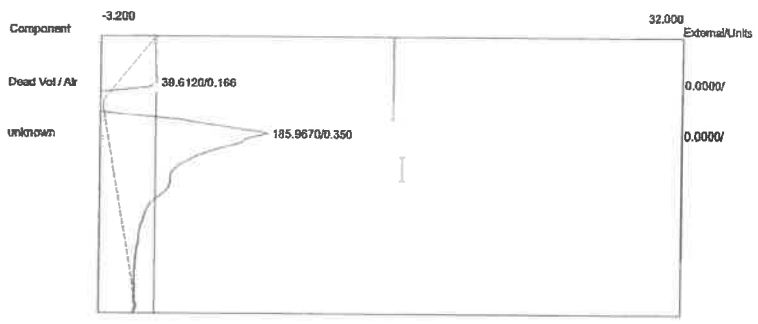
Component	Retention	Area	External	Units
Dead Vol / Air	0.100	30.5800	0.0000	
		30.5800	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:17:00
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-2B01.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



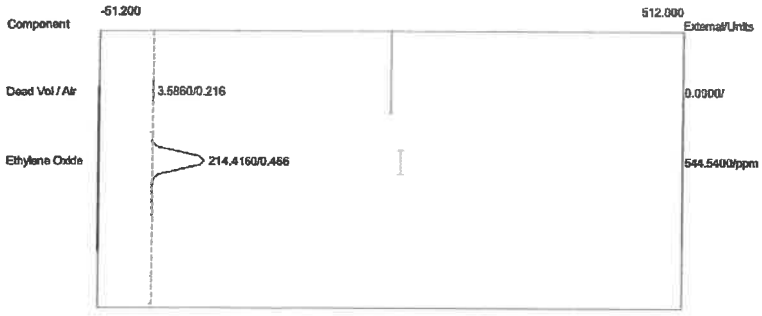
Component	Retention	Area	External	Units
Dead Vol / Air	0.216	1.5135	0.0000	
Ethylene Oxide	0.466	5.1000	12.9522	ppm
		6.6135	12.9522	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:17:00
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-2B01.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



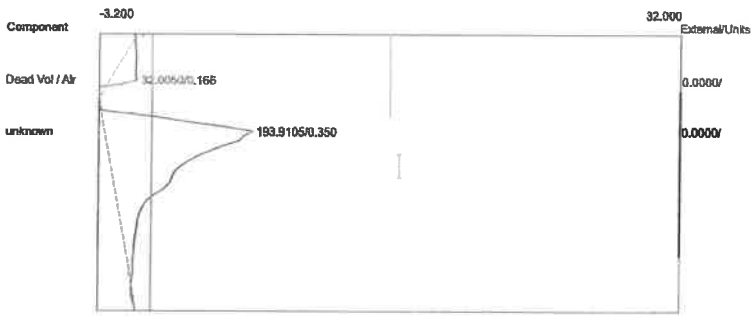
Component	Retention	Area	External	Units
Dead Vol / Air	0.166	39.6120	0.0000	
		39.6120	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:18:06
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-2B02.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



Component	Retention	Area	External	Units
Dead Vol / Air	0.216	3.5860	0.0000	
Ethylene Oxide	0.466	214.4160	544.5400	ppm
		218.0020	544.5400	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:18:06
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-2B02.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer

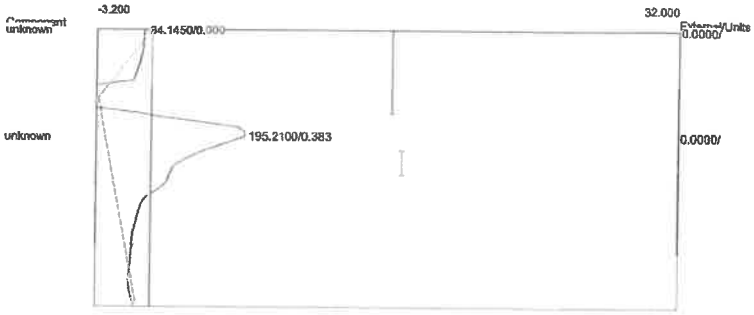


Component	Retention	Area	External	Units
Dead Vol / Air	0.166	32.0050	0.0000	
		32.0050	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:19:13
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-2B03.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer

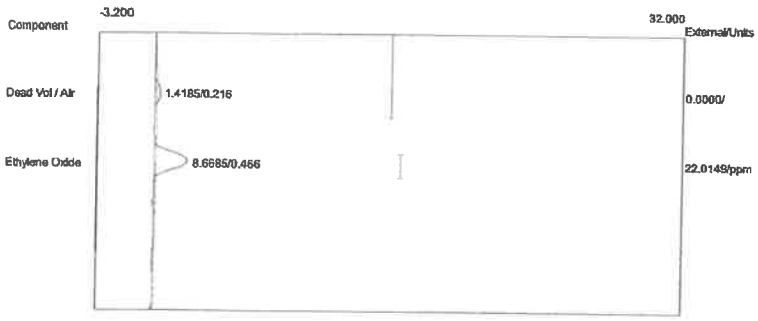
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	2.4175	0.0000	
Ethylene Oxide	0.483	19.6690	49.9522	ppm
		22.0865	49.9522	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:19:13
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-2B03.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



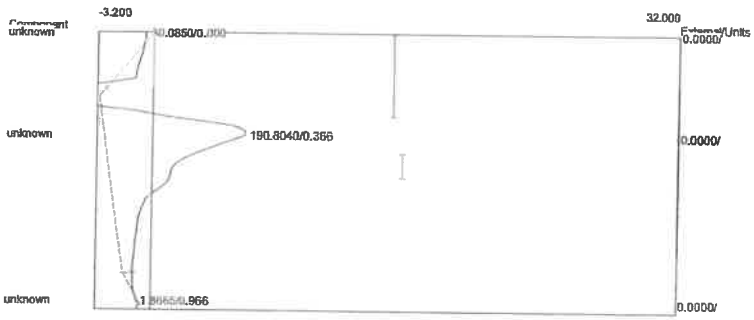
Component	Retention	Area	External	Units
		0.0000	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:20:20
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-2B04.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



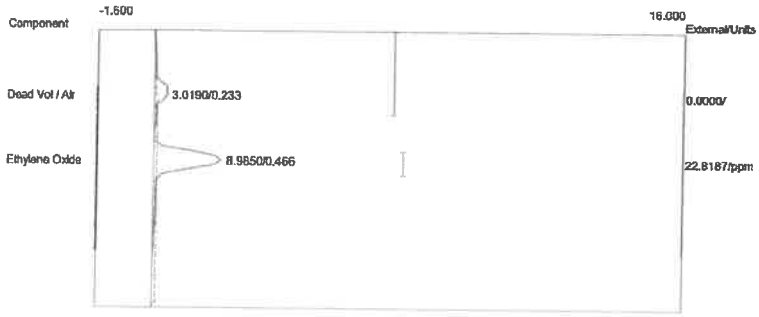
Component	Retention	Area	External	Units
Dead Vol / Air	0.216	1.4185	0.0000	
Ethylene Oxide	0.466	8.6685	22.0149	ppm
		10.0870	22.0149	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:20:20
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-2B04.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



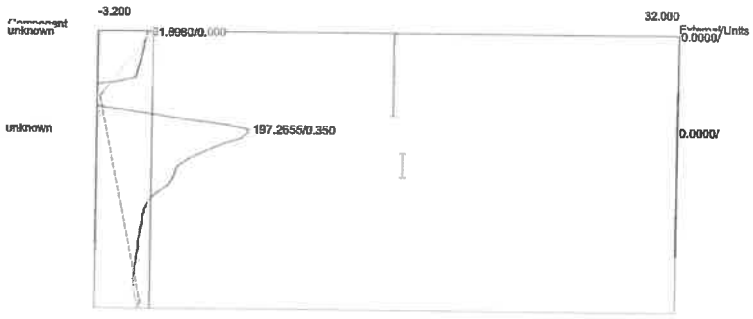
Component	Retention	Area	External	Units
		0.0000	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:21:26
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-2B05.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



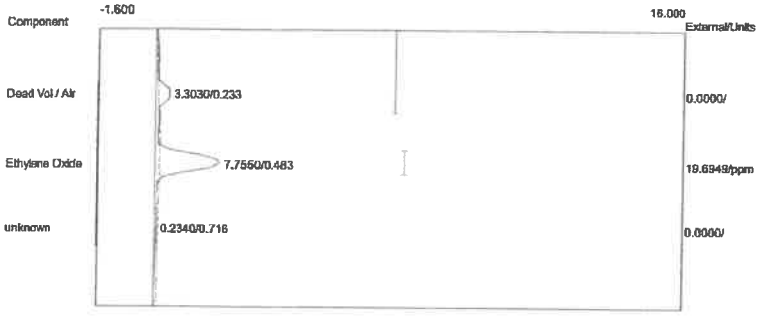
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	3.0190	0.0000	
Ethylene Oxide	0.466	8.9850	22.8187	ppm
		12.0040	22.8187	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:21:26
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-2B05.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



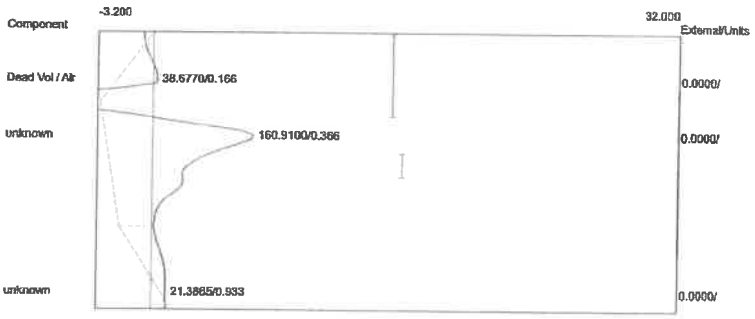
Component	Retention	Area	External	Units
		0.0000	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:22:48
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-2B06.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



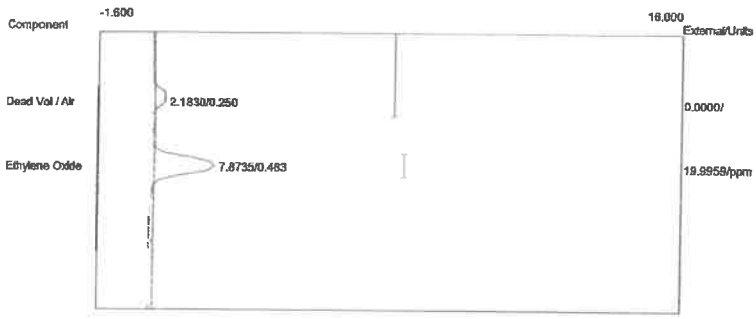
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	3.3030	0.0000	
Ethylene Oxide	0.483	7.7550	19.6949	ppm
		11.0580	19.6949	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:22:48
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-2B06.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



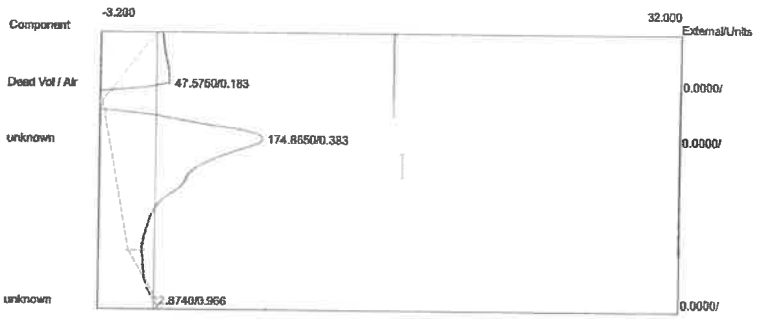
Component	Retention	Area	External	Units
Dead Vol / Air	0.166	38.6770	0.0000	
		38.6770	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:23:56
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-2B07.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



Component	Retention	Area	External	Units
Dead Vol / Air	0.250	2.1830	0.0000	
Ethylene Oxide	0.483	7.8735	19.9959	ppm
		10.0565	19.9959	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:23:56
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-2B07.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer

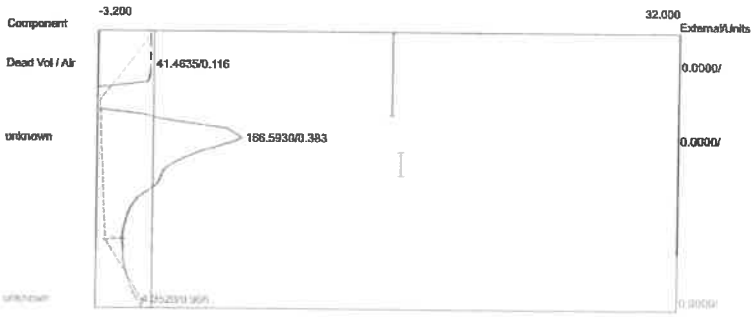


Component	Retention	Area	External	Units
Dead Vol / Air	0.183	47.5750	0.0000	
		47.5750	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:25:05
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-2B08.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer

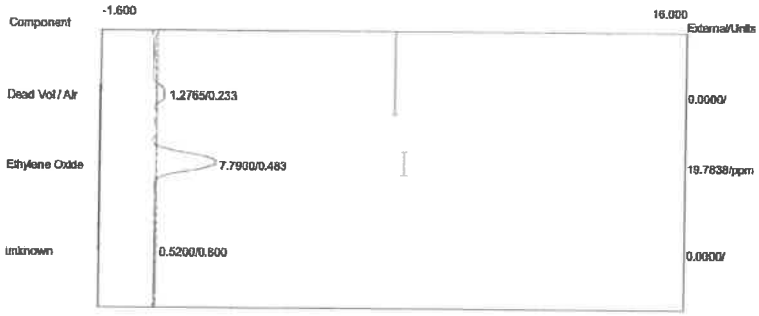
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	2.2020	0.0000	
Ethylene Oxide	0.483	8.0620	20.4746	ppm
		10.2640	20.4746	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:25:05
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-2B08.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



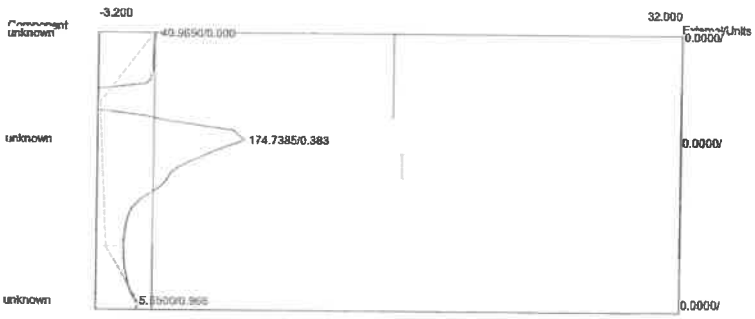
Component	Retention	Area	External	Units
Dead Vol / Air	0.116	41.4635	0.0000	
		41.4635	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:26:10
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-2B09.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.2765	0.0000	
Ethylene Oxide	0.483	7.7900	19.7838	ppm
		9.0665	19.7838	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:26:10
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-2B09.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer

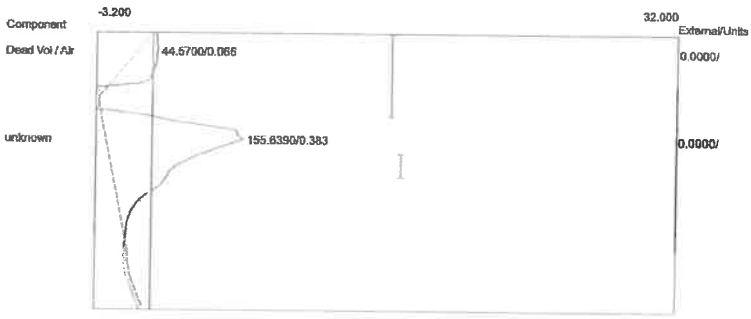


Component	Retention	Area	External	Units
		0.0000	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:27:17
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-2B10.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer

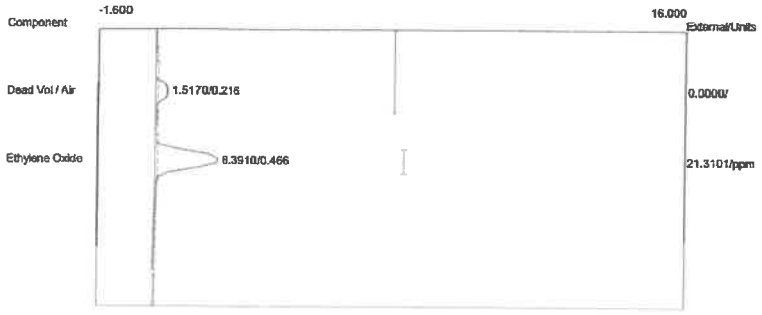
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	2.1500	0.0000	
Ethylene Oxide	0.466	7.6645	19.4651	ppm
		9.8145	19.4651	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:27:17
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-2B10.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



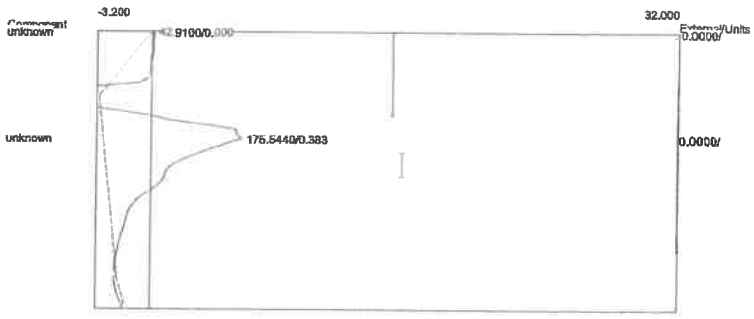
Component	Retention	Area	External	Units
Dead Vol / Air	0.066	44.5700	0.0000	
		44.5700	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:28:25
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-2B11.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



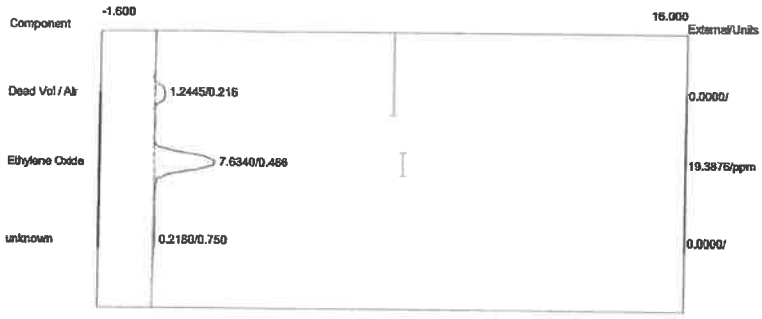
Component	Retention	Area	External	Units
Dead Vol / Air	0.216	1.5170	0.0000	
Ethylene Oxide	0.466	8.3910	21.3101	ppm
		9.9080	21.3101	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:28:25
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-2B11.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



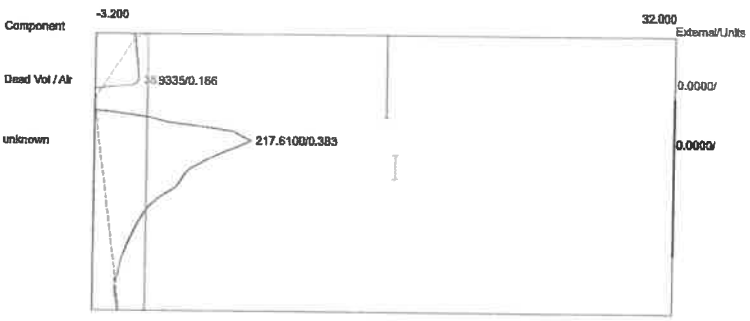
Component	Retention	Area	External	Units
		0.0000	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:29:31
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-2B12.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



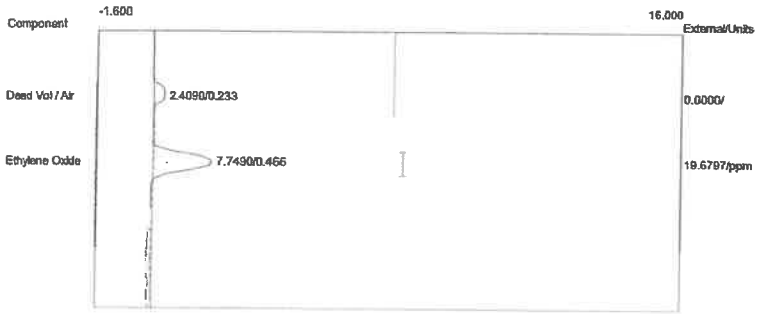
Component	Retention	Area	External	Units
Dead Vol / Air	0.216	1.2445	0.0000	
Ethylene Oxide	0.466	7.6340	19.3876	ppm
		8.8785	19.3876	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:29:31
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-2B12.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



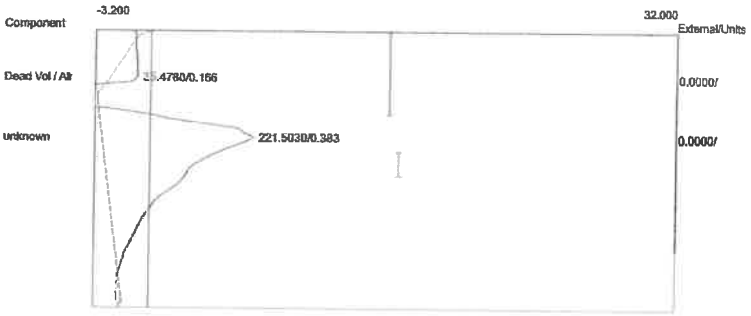
Component	Retention	Area	External	Units
Dead Vol / Air	0.166	35.9335	0.0000	
		35.9335	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:30:38
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-2B13.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



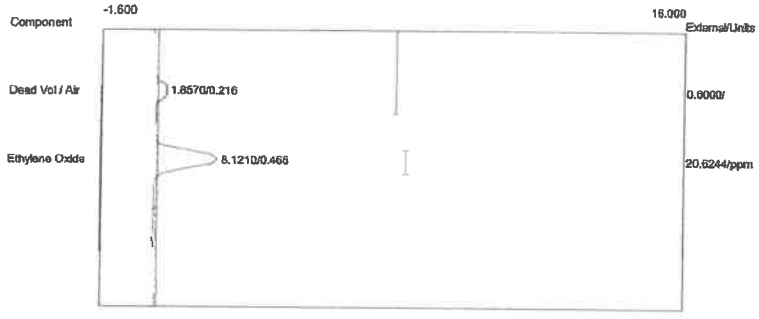
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	2.4090	0.0000	
Ethylene Oxide	0.466	7.7490	19.6797	ppm
		10.1580	19.6797	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#2BV
Analysis date: 09/20/2018 16:30:38
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-2B13.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



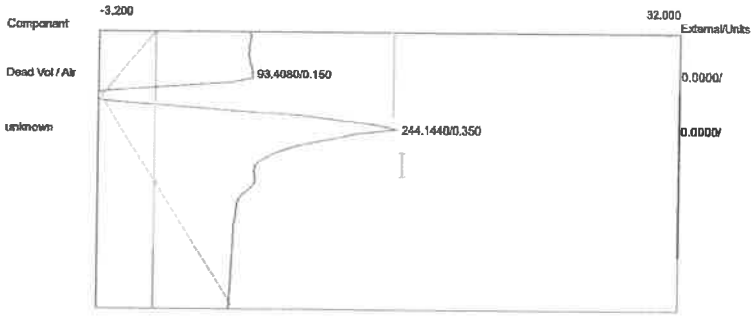
Component	Retention	Area	External	Units
Dead Vol / Air	0.166	35.4780	0.0000	
		35.4780	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 16:51:01
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-3B01.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



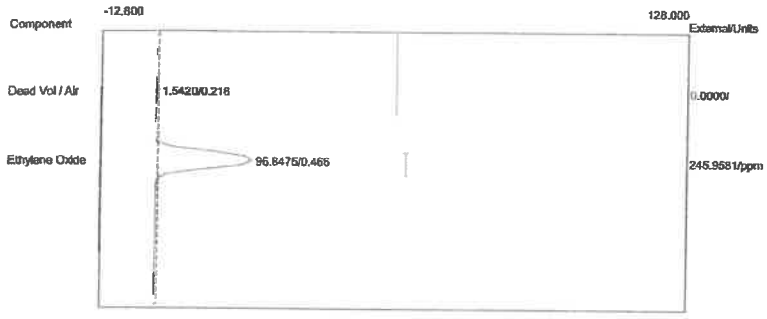
Component	Retention	Area	External	Units
Dead Vol / Air	0.216	1.8570	0.0000	
Ethylene Oxide	0.466	8.1210	20.6244	ppm
		9.9780	20.6244	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 16:51:01
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-3B01.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



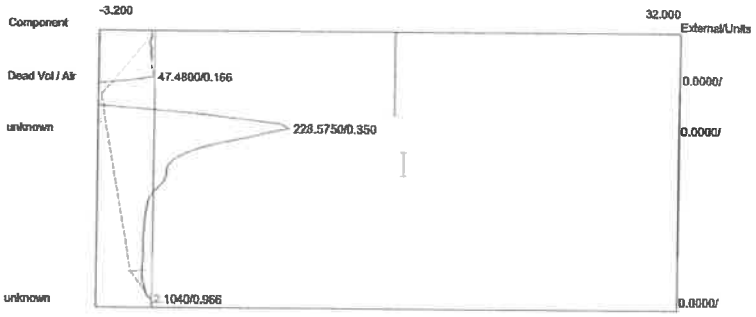
Component	Retention	Area	External	Units
Dead Vol / Air	0.150	93.4080	0.0000	
		93.4080	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 16:52:10
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-3B02.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



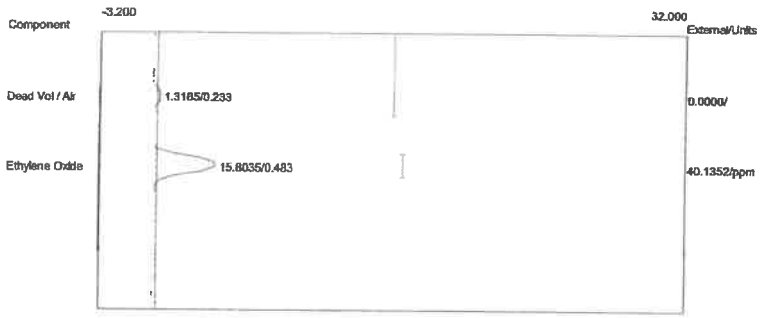
Component	Retention	Area	External	Units
Dead Vol / Air	0.216	1.5420	0.0000	
Ethylene Oxide	0.466	96.8475	245.9581	ppm
		98.3895	245.9581	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 16:52:10
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-3B02.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



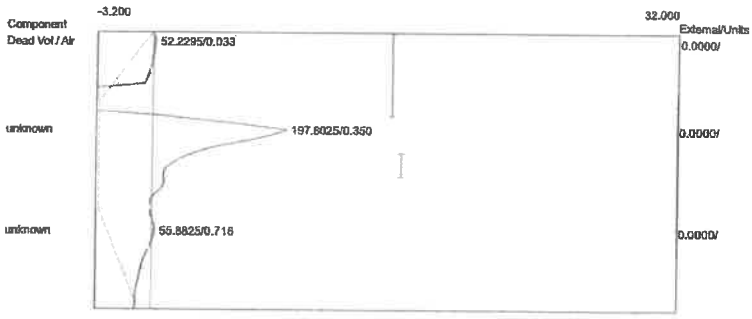
Component	Retention	Area	External	Units
Dead Vol / Air	0.166	47.4800	0.0000	
		47.4800	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 16:53:38
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-3B03.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



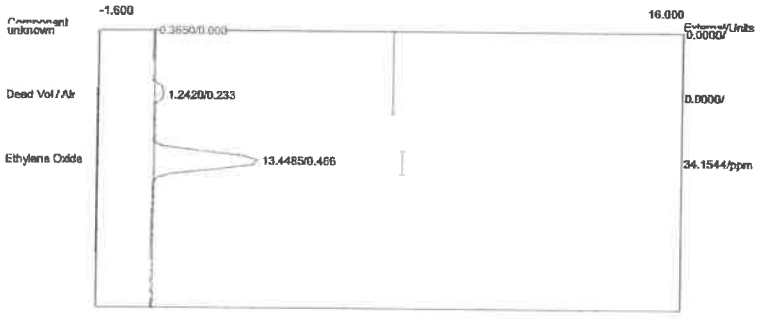
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.3185	0.0000	
Ethylene Oxide	0.483	15.8035	40.1352	ppm
		17.1220	40.1352	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 16:53:38
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-3B03.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



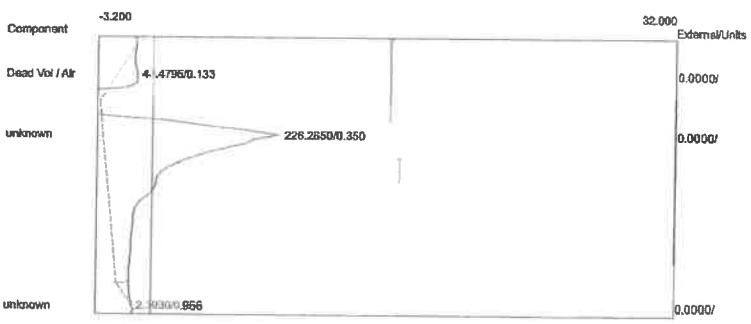
Component	Retention	Area	External	Units
Dead Vol / Air	0.033	52.2295	0.0000	
		52.2295	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 16:54:45
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-3B04.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



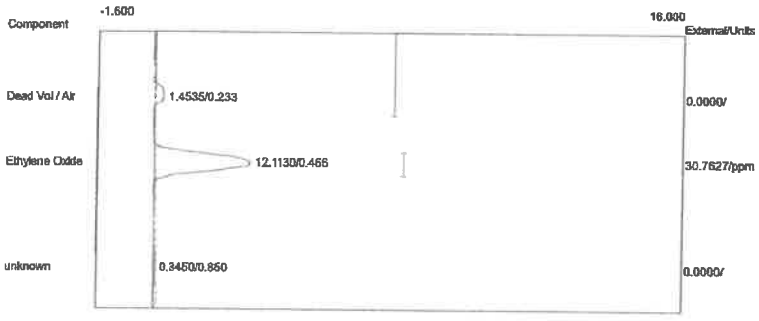
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.2420	0.0000	
Ethylene Oxide	0.466	13.4485	34.1544	ppm
		14.6905	34.1544	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 16:54:45
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-3B04.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



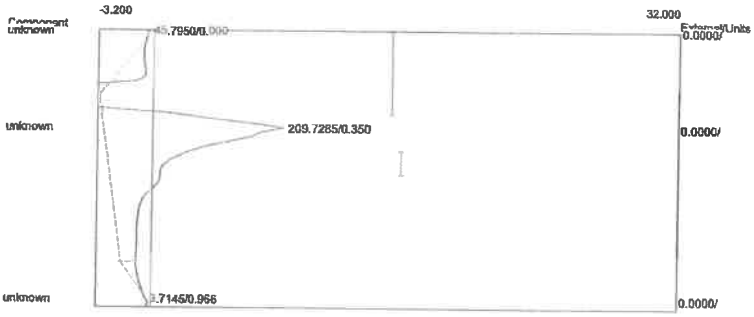
Component	Retention	Area	External	Units
Dead Vol / Air	0.133	43.4795	0.0000	
		43.4795	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 16:55:55
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-3B05.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



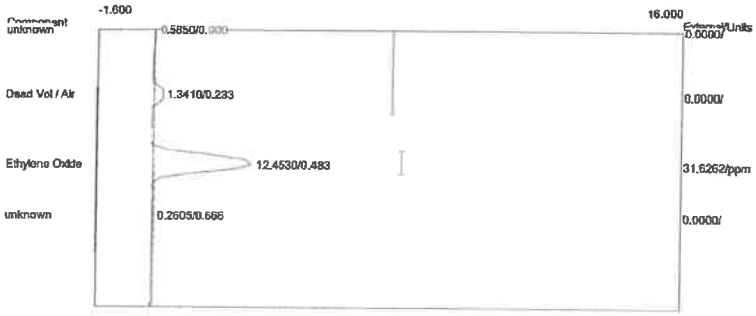
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.4535	0.0000	
Ethylene Oxide	0.466	12.1130	30.7627	ppm
		13.5665	30.7627	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 16:55:55
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-3B05.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



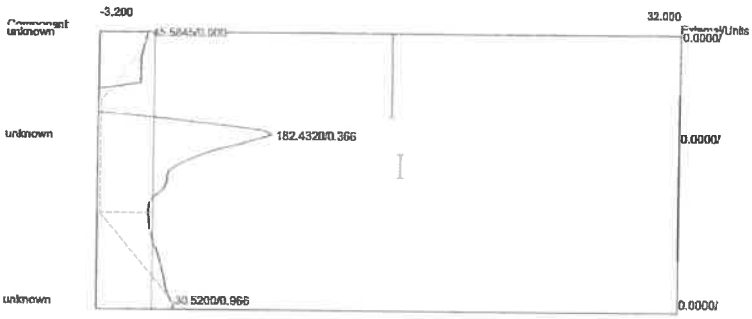
Component	Retention	Area	External	Units
		0.0000	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 16:57:02
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-3B06.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



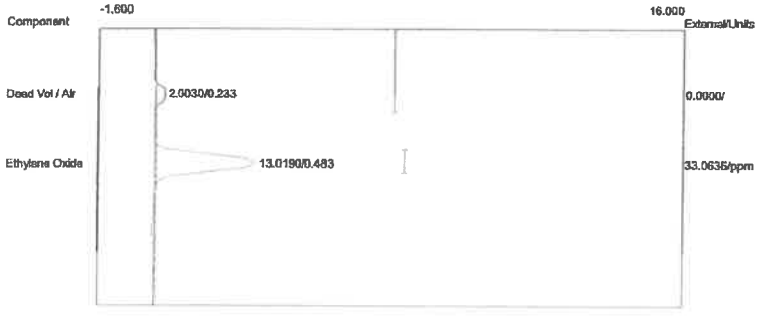
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.3410	0.0000	
Ethylene Oxide	0.483	12.4530	31.6262	ppm
		13.7940	31.6262	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 16:57:02
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-3B06.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



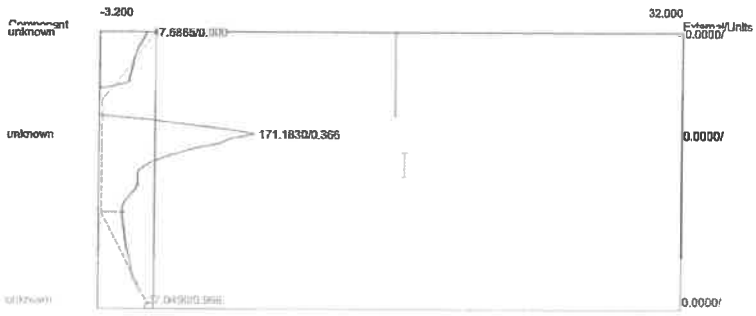
Component	Retention	Area	External	Units
		0.0000	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 16:58:12
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-3B07.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



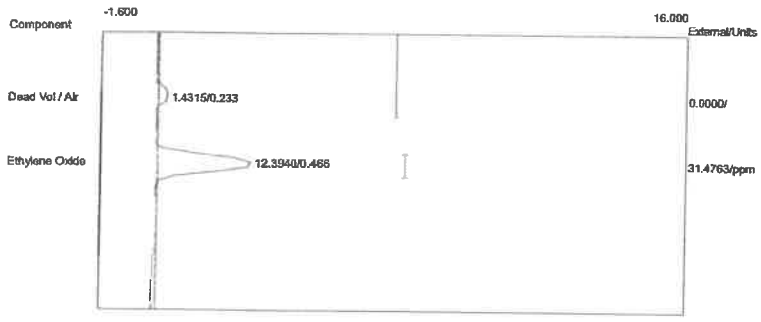
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	2.0030	0.0000	
Ethylene Oxide	0.483	13.0190	33.0636	ppm
		15.0220	33.0636	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 16:58:12
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-3B07.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



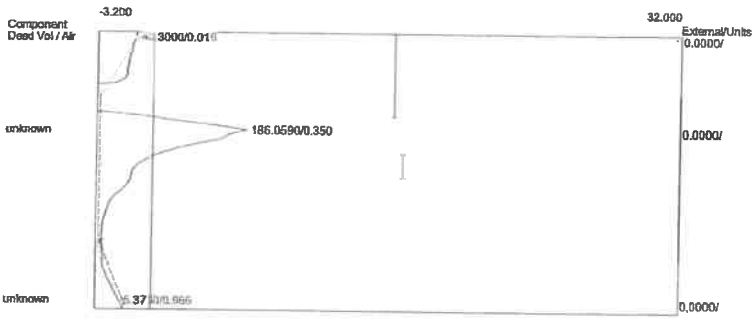
Component	Retention	Area	External	Units
		0.0000	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 16:59:22
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-3B08.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



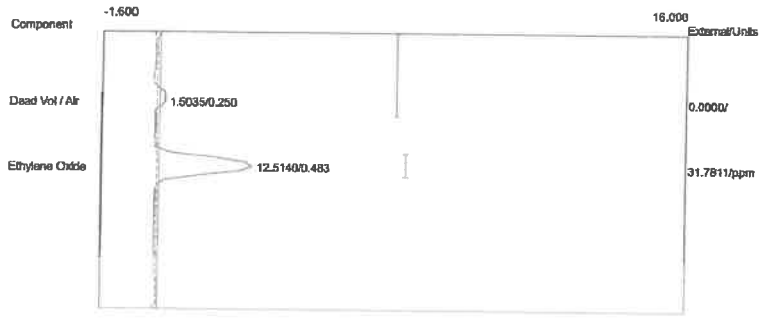
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.4315	0.0000	
Ethylene Oxide	0.466	12.3940	31.4763	ppm
		13.8255	31.4763	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 16:59:22
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-3B08.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



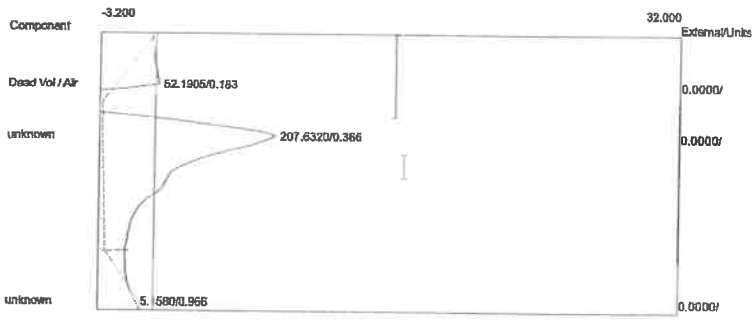
Component	Retention	Area	External	Units
Dead Vol / Air	0.016	43.3000	0.0000	
		43.3000	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 17:00:31
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-3B09.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



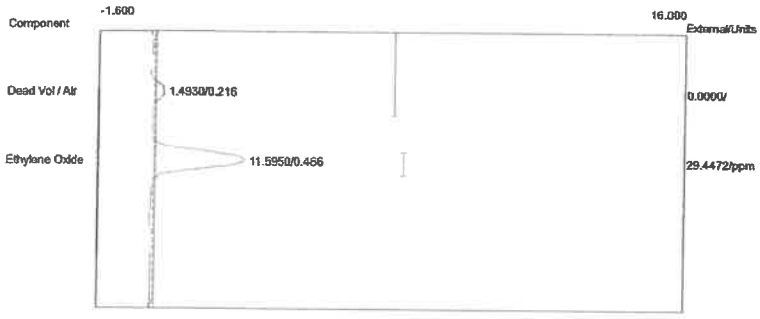
Component	Retention	Area	External	Units
Dead Vol / Air	0.250	1.5035	0.0000	
Ethylene Oxide	0.483	12.5140	31.7811	ppm
		14.0175	31.7811	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 17:00:31
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-3B09.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



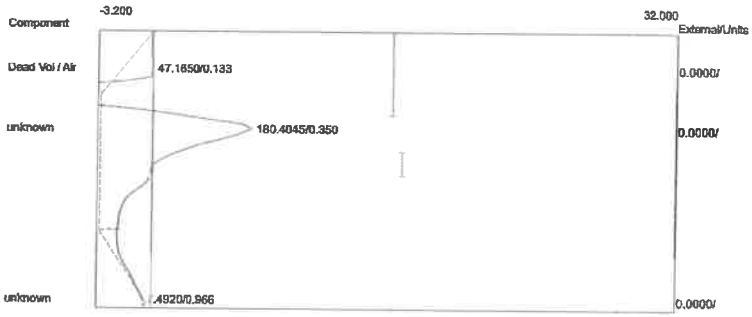
Component	Retention	Area	External	Units
Dead Vol / Air	0.183	52.1905	0.0000	
		52.1905	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 17:01:45
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-3B10.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



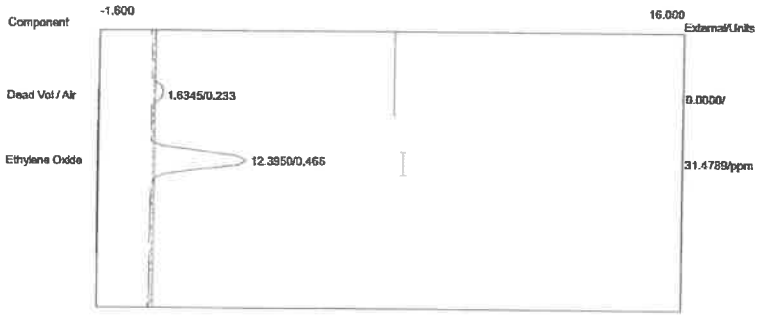
Component	Retention	Area	External	Units
Dead Vol / Air	0.216	1.4930	0.0000	
Ethylene Oxide	0.466	11.5950	29.4472	ppm
		13.0880	29.4472	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 17:01:45
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-3B10.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



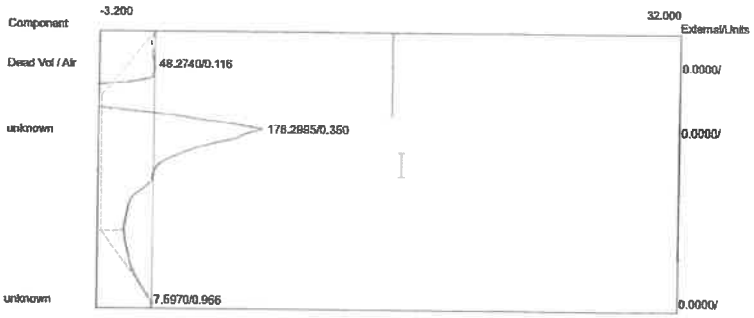
Component	Retention	Area	External	Units
Dead Vol / Air	0.133	47.1650	0.0000	
		47.1650	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 17:02:56
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-3B11.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



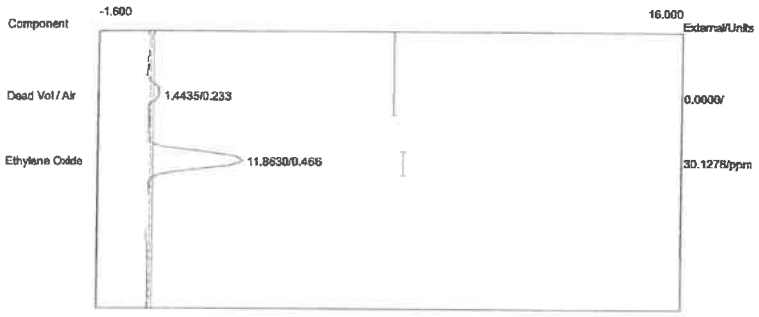
Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.6345	0.0000	
Ethylene Oxide	0.466	12.3950	31.4789	ppm
		14.0295	31.4789	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 17:02:56
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-3B11.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



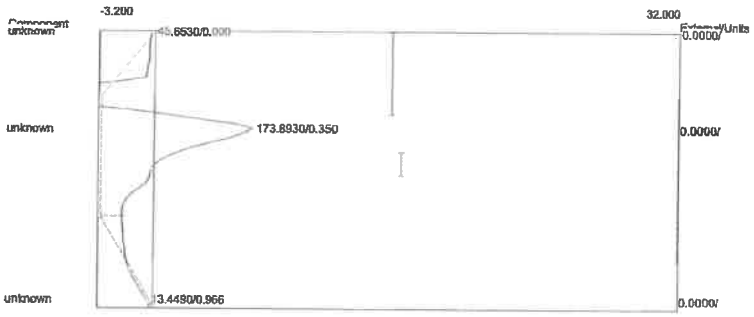
Component	Retention	Area	External	Units
Dead Vol / Air	0.116	48.2740	0.0000	
		48.2740	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 17:04:06
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-3B12.CHR (c:\peak359)
Sample: AAT Inlet
Operator: D. Kremer



Component	Retention	Area	External	Units
Dead Vol / Air	0.233	1.4435	0.0000	
Ethylene Oxide	0.466	11.8630	30.1278	ppm
		13.3065	30.1278	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: Run#3BV
Analysis date: 09/20/2018 17:04:06
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-3B12.CHR (c:\peak359)
Sample: AAT Outlet
Operator: D. Kremer



Component	Retention	Area	External	Units
		0.0000	0.0000	

APPENDIX F

Field Data

ECSi

Elev **620ft** **41.79 °N, 87.75 °W**

Chicago-Midway, IL ★

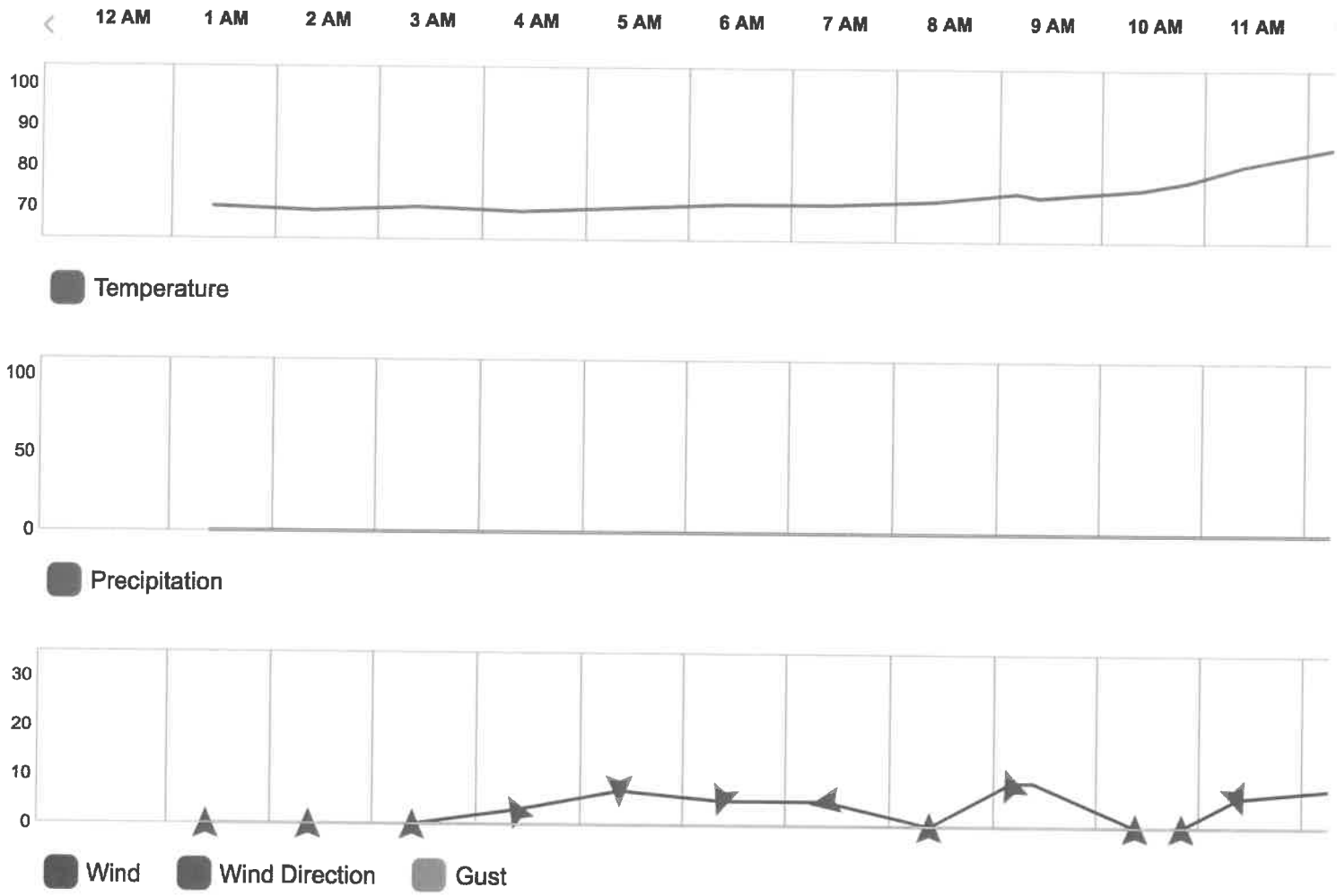
58° CHICAGO-MIDWAY STATION (/HISTORY/DAILY/US/IL/CHICAGO-MIDWAY/KMDW/DATE/2018-10-16?CM_VEN=LOCALWX_PWSDASH) | CHANGE

HISTORY (/HISTORY/DAILY/US/IL/CHICAGO-MIDWAY/KMDW/DATE/2018-10-16)

- TODAY (/WEATHER/US/IL/CHICAGO/KMDW)
- HOURLY (/HOURLY/US/IL/CHICAGO/KMDW)
- 10-DAY (/FORECAST/US/IL/CHICAGO/KMDW)
- CALENDAR (/CALENDAR/US/IL/CHICAGO-MIDWAY/KMDW/DATE/2018-10)
- HISTORY (/HISTORY/DAILY/US/IL/CHICAGO-MIDWAY/KMDW/DATE/2018-10-16)
- WUNDERMAP (/WUNDERMAP?LAT=41.78583145&LON=-87.75222015)

Daily | Weekly | Monthly

September | 20 | 2018 | View



Summary

Temperature (° F)	Actual	Historic Avg.	Record
High Temp	95	74	95
Low Temp	68	56	38
Day Average Temp	82	65	-
Precipitation (Inches)	Actual	Historic Avg.	Record
Precipitation	0	0.12	1.12
Month to Date	1.48	2.26	-
Year to Date	27.28	28.81	-
Degree Days (° F)	Actual	Historic Avg.	Record

Temperature (° F)	Actual	Historic Avg.	Record
Heating Degree Days	0	3	-
HDD Month to Date	0	32	-
HDD Since July 1	0	37	-
Cooling Degree Days	17	3	-
CDD Month to Date	190	100	-
CDD Year to Date	1355	1010	-
Growing Degree Days	32	-	-
Dew Point (° F)	Actual	Historic Avg.	Record
Dew Point	68	-	-
High	72	-	-
Low	65	-	-
Average	68	-	-
Wind (MPH)	Actual	Historic Avg.	Record
Max Wind Speed	22	-	-
Visibility	10	-	-
Sea Level Pressure (Hg)	Actual	Historic Avg.	Record
Sea Level Pressure	29.98	-	-
Astronomy	Day Length	Rise	Set
Actual Time	12h 16m	6:37 AM	6:53 PM
Civil Twilight		6:09 AM	7:21 PM
Nautical Twilight		5:37 AM	7:54 PM
Astronomical Twilight		5:03 AM	8:27 PM
Moon: waxing gibbous		4:54 PM	2:04 AM

Daily Observations

Time	Temperature	Dew Point	Humidity	Wind	Wind Speed	Wind Gust	Pressure	Precip.	Precip Accum
12:53 AM	70 ° F	66 ° F	87 %	CALM	0 mph	0 mph	29.3 in	0.0 in	0.0 in
1:53 AM	69 ° F	65 ° F	87 %	CALM	0 mph	0 mph	29.3 in	0.0 in	0.0 in
2:53 AM	70 ° F	66 ° F	87 %	CALM	0 mph	0 mph	29.3 in	0.0 in	0.0 in
3:53 AM	69 ° F	66 ° F	90 %	NNW	3 mph	0 mph	29.3 in	0.0 in	0.0 in
4:53 AM	70 ° F	66 ° F	87 %	S	7 mph	0 mph	29.3 in	0.0 in	0.0 in
5:53 AM	71 ° F	66 ° F	84 %	SSW	5 mph	0 mph	29.3 in	0.0 in	0.0 in
6:53 AM	71 ° F	67 ° F	87 %	W	5 mph	0 mph	29.3 in	0.0 in	0.0 in
7:53 AM	72 ° F	67 ° F	84 %	CALM	0 mph	0 mph	29.3 in	0.0 in	0.0 in
8:40 AM	74 ° F	68 ° F	82 %	NNW	9 mph	0 mph	29.3 in	0.0 in	0.0 in
8:53 AM	73 ° F	67 ° F	81 %	NNW	9 mph	0 mph	29.3 in	0.0 in	0.0 in
9:53 AM	75 ° F	68 ° F	79 %	CALM	0 mph	0 mph	29.3 in	0.0 in	0.0 in
10:20 AM	77 ° F	69 ° F	76 %	CALM	0 mph	0 mph	29.3 in	0.0 in	0.0 in
10:53 AM	81 ° F	70 ° F	69 %	SSE	6 mph	0 mph	29.3 in	0.0 in	0.0 in
11:53 AM	86 ° F	72 ° F	63 %	SSW	8 mph	0 mph	29.3 in	0.0 in	0.0 in
12:53 PM	89 ° F	72 ° F	57 %	SSW	12 mph	20 mph	29.3 in	0.0 in	0.0 in
1:53 PM	92 ° F	71 ° F	50 %	SW	12 mph	20 mph	29.2 in	0.0 in	0.0 in
2:53 PM	95 ° F	70 ° F	44 %	SSW	15 mph	24 mph	29.2 in	0.0 in	0.0 in
3:53 PM	94 ° F	69 ° F	44 %	SSW	18 mph	29 mph	29.2 in	0.0 in	0.0 in
4:53 PM	94 ° F	67 ° F	41 %	SW	16 mph	30 mph	29.2 in	0.0 in	0.0 in
5:53 PM	93 ° F	67 ° F	42 %	SSW	16 mph	25 mph	29.1 in	0.0 in	0.0 in
6:53 PM	92 ° F	66 ° F	42 %	SSW	13 mph	24 mph	29.1 in	0.0 in	0.0 in
7:53 PM	90 ° F	66 ° F	45 %	SSW	17 mph	28 mph	29.1 in	0.0 in	0.0 in
8:53 PM	88 ° F	67 ° F	49 %	S	15 mph	26 mph	29.1 in	0.0 in	0.0 in
9:53 PM	87 ° F	66 ° F	49 %	SSW	18 mph	30 mph	29.1 in	0.0 in	0.0 in
10:53 PM	85 ° F	67 ° F	55 %	SSW	20 mph	32 mph	29.2 in	0.0 in	0.0 in
11:53 PM	83 ° F	66 ° F	56 %	SSW	17 mph	30 mph	29.2 in	0.0 in	0.0 in

Our Apps (/download)

Weather API (/weather/api)

Full Screen Weather (/fullscreenweather)

Personal Weather Stations (/weatherstation/)

Site Map (/sitemap/)

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AdChoices (/company/ad-choices)

Data Rights (/privacy-settings)

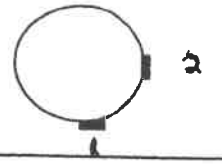
Hosted on the IBM Cloud (https://www.ibm.com/cloud/)

ECSI, INC. - VELOCITY TRAVERSE DATA

Client: Sterigenics | Run #: 1 | Date: ~~9/8/2018~~ 9/20/18 | Port Sketch:

Location: Willowbrook - Plant 2 | Probe Type: Std. | Baro Press: ~~29.35~~ 29.15

Source: AAT Safe Cell System Inlet | Stack I.D.: 28 In. | DSCFM:



	Port 1							Port 2						
Inches From Port	Point#	Delta P Low	Delta P High	Delta P Average	Delta P Sq Root	Stack Temp (F)	Cyclonic Angle	Point#	Delta P Low	Delta P High	Delta P Average	Delta P Sq Root	Stack Temp (F)	Cyclonic Angle
0.5	1	0.40	0.40	#DIV/0!	#DIV/0!	88.2	7.2	1	0.50	0.50	#DIV/0!	#DIV/0!	90.4	4.7
1.9	2	0.25	0.25	#DIV/0!	#DIV/0!	88.2	6.3	2	0.25	0.25	#DIV/0!	#DIV/0!	89.9	5.4
3.3	3	0.20	0.20	#DIV/0!	#DIV/0!	88.5	3.4	3	0.30	0.30	#DIV/0!	#DIV/0!	93.3	4.8
4.9	4	0.25	0.25	#DIV/0!	#DIV/0!	91.2	4.8	4	0.35	0.35	#DIV/0!	#DIV/0!	95.4	3.6
7.0	5	0.25	0.25	#DIV/0!	#DIV/0!	93.5	3.6	5	0.40	0.40	#DIV/0!	#DIV/0!	96.7	3.2
10.0	6	0.35	0.35	#DIV/0!	#DIV/0!	95.8	4.7	6	0.45	0.45	#DIV/0!	#DIV/0!	97.4	2.1
18.0	7	0.45	0.45	#DIV/0!	#DIV/0!	95.6	3.8	7	0.45	0.45	#DIV/0!	#DIV/0!	96.7	4.8
21.0	8	0.45	0.45	#DIV/0!	#DIV/0!	96.7	3.7	8	0.47	0.47	#DIV/0!	#DIV/0!	97.6	3.9
23.1	9	0.45	0.45	#DIV/0!	#DIV/0!	97.4	5.1	9	0.40	0.45	#DIV/0!	#DIV/0!	98.0	5.1
24.7	10	0.45	0.45	#DIV/0!	#DIV/0!	97.9	4.5	10	0.45	0.45	#DIV/0!	#DIV/0!	98.4	5.4
26.1	11	0.45	0.45	#DIV/0!	#DIV/0!	98.2	3.6	11	0.48	0.48	#DIV/0!	#DIV/0!	98.4	3.8
27.5	12	0.30	0.30	#DIV/0!	#DIV/0!	97.4	2.2	12	0.35	0.35	#DIV/0!	#DIV/0!	98.3	2.0
	13							13						
	14							14						
	15							15						
	16							16						
	17							17						
	18							18						
	19							19						
	20							20						
	21							21						
	22							22						
	23							23						
	24							24						
								Average Values:	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		

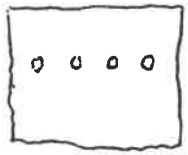
*Stack static pressure measured at -0.35" H_2O

*Pitot tube P-6-4 (s-type) was leak checked @ 2" H_2O, max scale on the manometer.

1 2 3 4

ECSI, INC. - VELOCITY TRAVERSE DATA

Client: Sterigenics Run #: 1 Date: ~~9/8/2016~~ 9/20/18 Port Sketch:



Location: Willowbrook - Plant 2 Probe Type: Std. Baro Press: ~~29.35~~ 29.15

Source: AAT Safe Cell System Outlet Stack I.D.: 28x28 = 5.44 ft² DSCFM:

	Port 1 & 2							Port 3 & 4						
Inches From Port	Point#	Delta P Low	Delta P High	Delta P Average	Delta P Sq Root	Stack Temp (F)	Cyclonic Angle	Point#	Delta P Low	Delta P High	Delta P Average	Delta P Sq Root	Stack Temp (F)	Cyclonic Angle
3.5	1	0.5	.5	#DIV/0!	#DIV/0!	100.5	3.9	1	0.3	0.3	#DIV/0!	#DIV/0!	99.9	4.4
7.0	2	0.55	0.55	#DIV/0!	#DIV/0!	102.2	3.9	2	0.25	0.25	#DIV/0!	#DIV/0!	101.5	5.4
10.5	3	0.6	0.6	#DIV/0!	#DIV/0!	102.2	2.6	3	0.25	0.25	#DIV/0!	#DIV/0!	102.2	5.6
14.0	4	~~0.6~~ 0.6	~~0.6~~ 0.6	#DIV/0!	#DIV/0!	102.2	2.6	4	0.20	0.20	#DIV/0!	#DIV/0!	102.4	3.1
17.5	5	0.55	0.55	#DIV/0!	#DIV/0!	102.1	2.5	5	0.15	0.15	#DIV/0!	#DIV/0!	102.3	1.8
21.0	6	0.6	0.6	#DIV/0!	#DIV/0!	102.1	2.1	6	0.20	0.20	#DIV/0!	#DIV/0!	102.4	2.5
24.5	7	0.6	0.6	#DIV/0!	#DIV/0!	102.1	3.8	7	0.20	0.20	#DIV/0!	#DIV/0!	102.3	2.0
3.5	1	0.4	0.4	#DIV/0!	#DIV/0!	99.4	1.1	1	0.15	0.15	#DIV/0!	#DIV/0!	101.0	4.2
7.0	2	0.4	0.4	#DIV/0!	#DIV/0!	101.4	6.2	2	0.15	0.15	#DIV/0!	#DIV/0!	101.8	5.0
10.5	3	0.4	0.4	#DIV/0!	#DIV/0!	102.2	2.0	3	0.10	0.10	#DIV/0!	#DIV/0!	101.7	1.2
14.0	4	0.3	0.3	#DIV/0!	#DIV/0!	102.3	4.4	4	0.10	0.10	#DIV/0!	#DIV/0!	102.3	4.7
17.5	5	0.3	0.3	#DIV/0!	#DIV/0!	102.2	4.7	5	0.10	0.10	#DIV/0!	#DIV/0!	102.4	1.8
21.0	6	0.4	0.4	#DIV/0!	#DIV/0!	102.3	5.1	6	0.10	0.10	#DIV/0!	#DIV/0!	102.4	0.8
24.5	7	0.4	0.4	#DIV/0!	#DIV/0!	102.3	4.6	7	0.10	0.10	#DIV/0!	#DIV/0!	102.0	2.5
								Average Values:	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

* Stack static pressure measured at 0.1" H_2O
* Pitot tube P-4-2 (S type) was leak checked @ 2" H_2O, max scale on the manometer
* Pitot tube std-1 (std.) was leak checked @ 2" H_2O, max scale on the manometer

WB2 — Run #1 — 9/20/18

Inj #	ΔP (inlet/outlet)	Temp (inlet/outlet)
1	.38 / .32	100 / 100
2	.38 / .32	101 / 101
3	.38 / .32	102 / 102
4	.38 / .32	101 / 101
5	.38 / .32	101 / 101
6	.38 / .32	102 / 102
7	.38 / .32	102 / 102
8	.38 / .32	102 / 102
9	.38 / .32	102 / 102
10	.38 / .32	103 / 103
11	.38 / .32	102 / 102
12	.38 / .32	103 / 103
13		
14		
15		

WB2 Run #2 9/20/18

Inj	ΔP In/out	Temp In/out
1	.38/.32	102/102
2	.38/.32	103/103
3	.38/.32	104/104
4	.38/.32	103/103
5	.38/.32	103/103
6	.38/.32	103/103
7	.38/.32	103/103
8	.38/.32	104/104
9	.38/.32	103/103
10	.38/.32	103/103
11	.38/.32	103/103
12	.38/.32	103/103
13	.38/.32	103/103
14		
15		

WB2 Run #3 9/20/18

Inj	ΔP In/out	Temp In/out
1	.38/.32	104/104
2	.38/.32	104/104
3	.38/.32	104/104
4	.38/.32	104/104
5	.38/.32	104/104
6	.38/.32	104/104
7	.38/.32	104/104
8	.38/.32	105/105
9	.38/.32	104/104
10	.38/.32	104/104
11	.38/.32	104/104
12	.38/.32	104/104
13		
14		
15		

APPENDIX G

Testing Equipment Information

ECSi

CleanAir.

CleanAir Instrument Rental
500 W. Wood Street
Palatine, IL 60067-4975
800-553-5511
www.cleanair.com

Pitot Tube Calibration

Probe Type: S-Type Pitot **I.D. Number:** P-6-4
Project Number:

Thermocouple Calibration

Reference Type: Thermometer Reference I.D. No: 1641582Rg Pyrometer I.D. No: 80512890 Units: °F

Point No.	Target Temp.	Reference Temp.	Indicated Temp.	Temp. Difference	% Difference*	Within spec?
1	Ambient					
2	200°F-250°F					

* Based on Absolute Temperature (Rankine) %Difference ≤ 1.5

Geometric Pitot Calibration

Is pitot assembly in good repair? ◉Yes ○No If no, explain:

"S" Pitot

Dimensions		Dimensions		Specifications	Within Spec?
α1=	1.0	α2=	0.0	<=10 °	YES
β1=	2.0	β2=	2.0	<=5°	YES
γ=	0.0	θ=	0.0	None	N/A
A=	0.718			None	N/A
Dt=	0.250			0.1875"<=Dt<=0.375"	YES

Calculations		Specifications	Within Spec?
A/2=Pa=Pb=	0.359 inches	None	N/A
Pa/Dt=Pb/Dt=	1.436 inches	1.05<P/Dt<1.5	YES
z = A sin γ =	0.000 inches	<=0.125"	YES
w = A sin θ =	0.000 inches	<=0.03125"	YES

Pitot Cp= 0.84 according to 40 CFR 60 section 10.1

Standard Pitot

	Measurement	Specification	Calculation	Within Spec?
Tube O.D.		None		
Static Hole I.D.		within 10% of (0.1*O.D.)		
Tip to Static		>=6*O.D.		
Static to Bend		>=8*O.D.		

Pitot Cp=

Calibrated by: Wayne Berry Date: 4/26/2018

CleanAir.

CleanAir Instrument Rental
500 W. Wood Street
Palatine, IL 60067-4975
800-553-5511
www.cleanair.com

Pitot Tube Calibration

Probe Type: S-Type Pitot **I.D. Number:** P-4-2
Project Number:

Thermocouple Calibration

Reference Type: Thermometer Reference I.D. No: 1641582Rg Pyrometer I.D. No: 80512890 Units: °F

Point No.	Target Temp.	Reference Temp.	Indicated Temp.	Temp. Difference	% Difference*	Within spec?
1	Ambient					
2	200°F-250°F					

* Based on Absolute Temperature (Rankine) %Difference ≤ 1.5

Geometric Pitot Calibration

Is pitot assembly in good repair? ◉Yes ○No If no, explain:

"S" Pitot

Dimensions		Dimensions		Specifications	Within Spec?
α1=	1.0	α2=	1.0	<=10 °	YES
β1=	-1.0	β2=	2.0	<=5°	YES
γ=	3.0	θ=	0.0	None	N/A
A=	0.731			None	N/A
Dt=	0.250			0.1875"<=Dt<=0.375"	YES

Calculations		Specifications	Within Spec?
A/2=Pa=Pb=	0.366 inches	None	N/A
Pa/Dt=Pb/Dt=	1.462 inches	1.05<P/Dt<1.5	YES
z = A sin γ =	0.036 inches	<=0.125"	YES
w = A sin θ =	0.000 inches	<=0.03125"	YES

Pitot Cp= 0.84 according to 40 CFR 60 section 10.1

Standard Pitot

	Measurement	Specification	Calculation	Within Spec?
Tube O.D.	1.000 inches	None		N/A
Static Hole I.D.		within 10% of (0.1*O.D.)		
Tip to Static		>=6*O.D.		
Static to Bend		>=8*O.D.		

Pitot Cp=

Calibrated by: Wayne Berry Date: 9/19/2018

Ulfig, Joseph

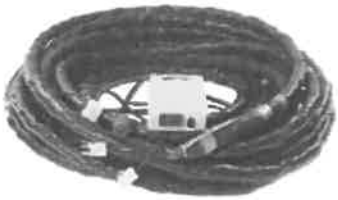
From: Bill Graham <bgraham@cleanair.com>
Sent: Wednesday, September 19, 2018 9:52 AM
To: Ulfig, Joseph
Subject: RE: Reference P-50998

Joe,
here is a cut sheet for heated lines directly from our Express Sales website. Sterigenics currently has one 0723-100 and one 0723-100HD.
the tubing is the same in both of them.

Regards,

Bill Graham Palatine Rental Team Leader
CleanAir Instrument Rental
500 W. Wood St. | Palatine, IL 60067
O: +1-800-553-5511 | rental.cleanair.com

HEATED SAMPLE LINES



These heated sample lines feature an electrically heat traced and insulated 3/8" Teflon ® PTFE (.030 Wall) sample line with a stainless steel over braid and stainless steel tube ends, a 1/4 Teflon ® PTFE (.040) calibration line, 3 pin Amphenol power connector, and 2 type K thermocouple plugs. Protected by a durable scuff resistant extruded polyurethane jacket. *Temperature controller sold separately. *These Heated Sample Lines are not self limiting, a temperature controller is required.

HEATED SAMPLE LINES ARE USED WITH:

- CEM Cateco - 0035RNT
- CEM 3 Point Probe - 0723123
- Temperature Controllers

HEAVY DUTY VERSUS STANDARD HEATED SAMPLE LINE

- **Note: Heavy Duty Heated Sample Lines HD are manufactured to have a continuous operating temperature of 400°F (~204°C) at an ambient temperature of -20°F.**
- **Note: Standard Heated Sample Lines are manufactured to have a continuous operating temperature of 400°F (~204°C) at an ambient temperature of 0°F.**

HEATED SAMPLE LINE FEATURES:

- Rated for 400 ° F continuous operation at -20 ° F ambient temperature
- Triple insulation maintains temperature of line with less power consumption. (Heavy Duty)
- Lower resistance heaters requires less power to heat lines.
- A backup type K thermocouple to prevent project delays in the case of primary thermocouple failure in the field.
- Stainless steel over braid and stainless steel tube ends for the sample line to prevent abrasive failure in the field. Optional stainless steel over braid for protection of calibration line from abrasive failure in the field.
- Durable extruded poly-urethane jacket for protection of sample/calibration lines from abrasive failure in the field.
- Inert teflon ® PTFE sample and calibration lines will provide more accurate results by eliminating potential bias from other materials. Teflon is also more corrosion resistant than tygon, and can be washed with acetone without degradation.

Part Number	Voltage	Watts	Length FT	Amp.
0723-10	120	300	10' Heated Sample Line	2.73
0723-25	120	750	25' Heated Sample Line	6.82
0723-50	120	1500	50' Heated Sample Line	13.64
0723-100	120	2500	100' Heated Sample Line	22.73
*0723-100HD	120	3000	100' Heavy Duty Heated Sample Line	27
0723-100220	120/240	N/A	100' Dual Voltage Heated Sample Line	N/A
0725RENT	Universal Temperature Controller			

Custom lengths, voltage, and configuration available***Heavy Duty Heated Sample Lines are manufactured to have a continuous operating temperature of 400°F (~204°C) at -20°F ambient temperature.**These Heated Sample Lines may be rented through CleanAir Rental

FLIR Commercial Systems, Inc.
9 Townsend West
Nashua, NH 03063 USA
Telephone: 603.324.7600
1-800-GOINFRA

Certificate of Compliance

We hereby certify that to the best of our knowledge, the instruments listed below meet or exceed the specifications stated in the appropriate instruction manuals. FLIR Commercial Systems, Inc., an ISO 9001:2008 certified company, inspects its incoming shipments using an approved sampling plan with an AQL. All incoming inspections are performed using test equipment that is traceable to National Standards.

CUSTOMER: ECSI, INC.
MODEL #: EA10
SERIAL#: 171103433

Dated this day: 04/03/2018

APPENDIX H

Sample Line Residence Time

ECSi

Sample Line Volume Calculation

Data: 100 ft of 3/8" Teflon line with wall thickness of .030"

Interior Volume Radius: (outside diameter/2) – (wall thickness) = (.375"/2) - .030" = 0.1575"

0.1575" * 1 ft/12 inches = 0.013125 feet

Cylindrical Volume = pi * r^2 * length = 3.1459 * $(0.013125)^2$ * 1 foot line length = 0.00054193 cubic feet per foot of line

0.00054193 cubic feet * 28316.8 cc / 1 cubic foot = 15.3457 cc per foot of line

For 100 foot of line, the total interior volume is 1535 cc.

Sample Residence Time Calculation

Sample Residence Time = Volume of sample lines / Sample pump flow rate

= 1535 cc / 500-1000 cc per minute = 1.54 - 3.07 minutes

APPENDIX I

Calibration Data

ECSi

ETHYLENE OXIDE SOURCE TEST/CALIBRATION DATA

Client: Sterigenics - Willowbrook 2

Source Tested: AAT Safe Cell System Date: 9/20/18

PRE CALIBRATION

	Calibration Gas Conc. (ppmv)	1.10 ppm EtO	10.1 ppm EtO	100 ppm EtO	1000 ppm EtO	10080 ppm EtO			
Inlet (FID)	Area Counts #1	.431	4.00	39.3					
	Area Counts #2/3	.432 / .432	3.96 / 3.96	39.4 / 39.3					
	Average Area	.4333	3.980	39.33			Sample Line Bias Calibration		
	Audit Standard (48.8 ppmv) Result						102.2 ppm (Std @ 100 ppmv)		

	Calibration Gas Conc. (ppmv)	1.10 ppm EtO	10.1 ppm EtO	100 ppm EtO					
Outlet (PID)	Area Counts #1	2.77	25.1	249					
	Area Counts #2/3	2.77 / 2.76	25.6 / 25.7	250 / 249					
	Average Area	2.767	25.47	249.3			Sample Line Bias Calibration		
	Audit Standard (48.8 ppmv) Result						101.5 ppm (Std @ 100 ppmv)		

	Run #1	Run #2	Run #3			
BV Start :	1538	1616	1650	P_{bar}: 29.15	EtO Usage (lbs/yr):	
BV Stop :	1553	1631	1705	$\%H_2O$:	Cycles Per Week:	

MID/POST CALIBRATION

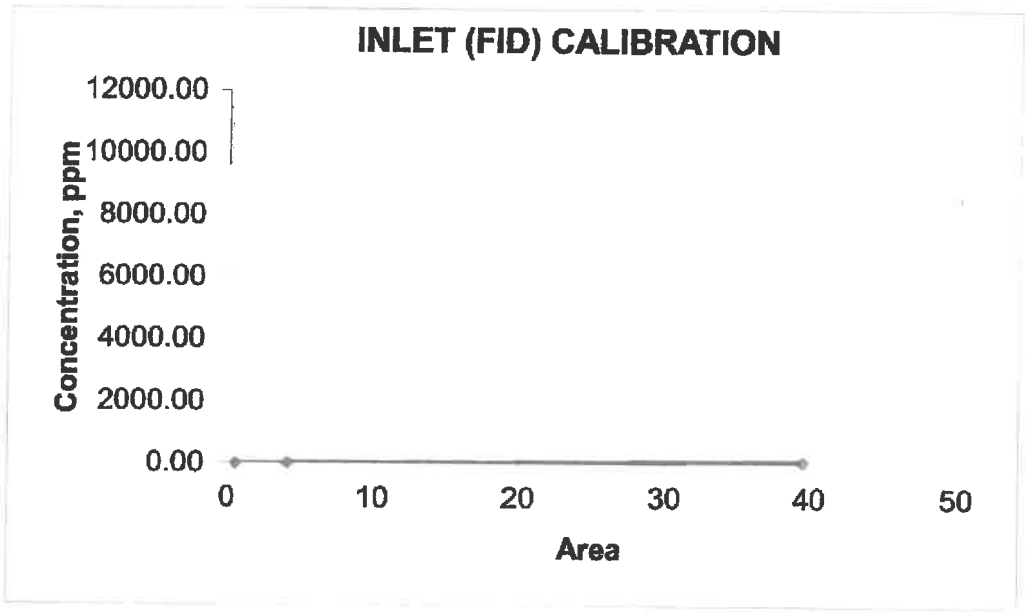
	Calibration Gas Conc. (ppmv)	1.10 ppm EtO	10.1 ppm EtO	100 ppm EtO	1000 ppm EtO	10080 ppm EtO			
Inlet (FID)	~~Mid Cal~~	Post Cal Sample Line Bias							
	Post Cal			39.7 = 100.9 ppm					
	Audit Standard (48.8 ppmv) Result								

	Calibration Gas Conc. (ppmv)	1.10 ppm EtO	10.1 ppm EtO	100 ppm EtO					
Outlet (PID)	~~Mid Cal~~	Post Cal Sample Line Bias							
	Post Cal		25.6 = 10.20 ppm						
	Audit Standard (48.8 ppmv) Result								

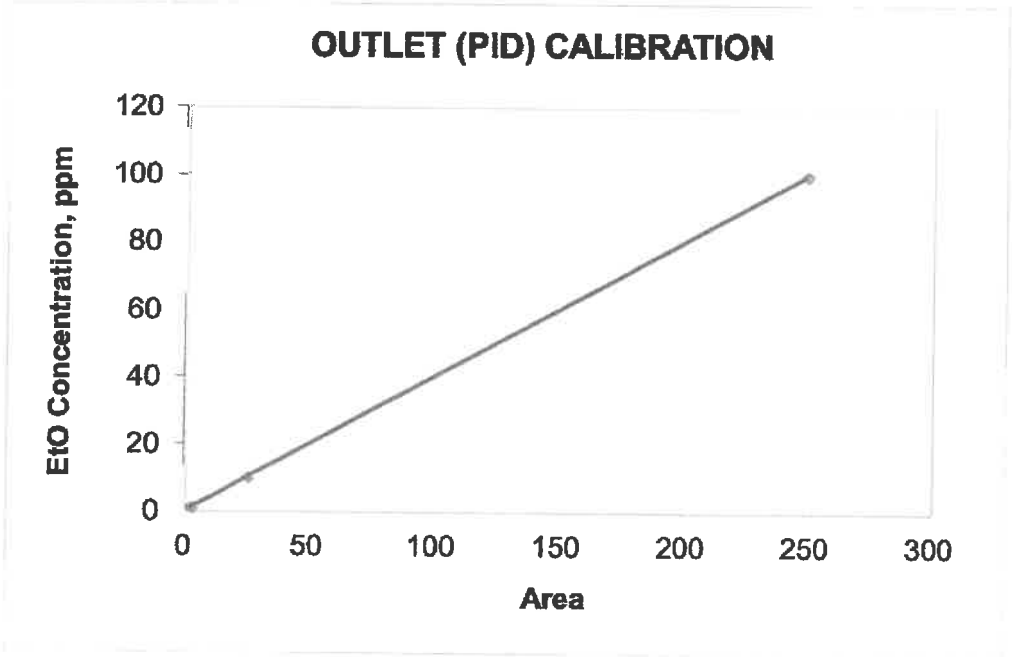
ECSi

EtO Calibrations

Site: **Sterigenics - Willowbrook 2**
Date: **9/20/2018**



Slope **2.54**
Intercept **-0.01**

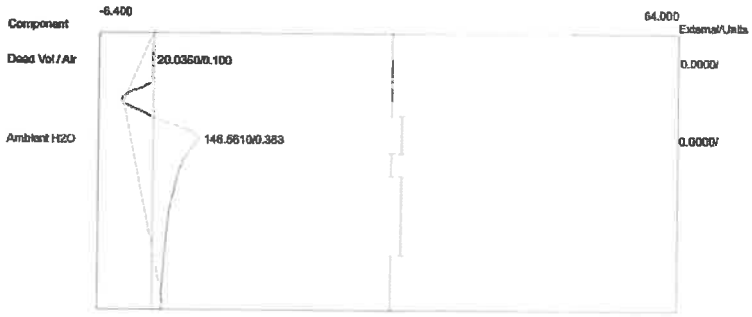


Slope **0.401**
Intercept **-0.0399**

Lab name: ECSI
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 09:34:38
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-Amb.CHR (c:\peak359)
Sample: Ambient Background
Operator: D. Kremer

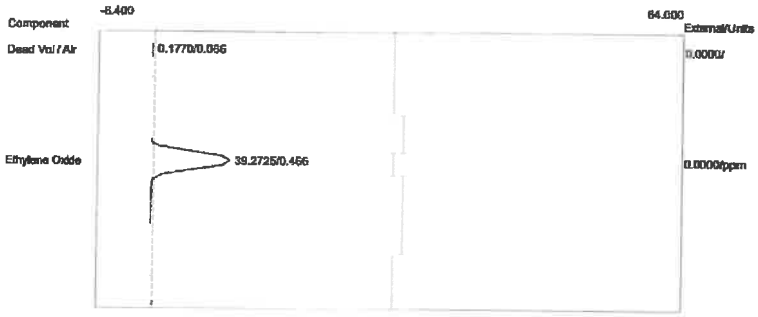
Component	Retention	Area	External	Units
Dead Vol / Air	0.216	2.0040	0.0000	
Acetaldehyde	0.716	0.2015	0.0000	
		2.2055	0.0000	

Lab name: ECSI
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 09:34:38
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-Amb.CHR (c:\peak359)
Sample: Ambient Background
Operator: D. Kremer



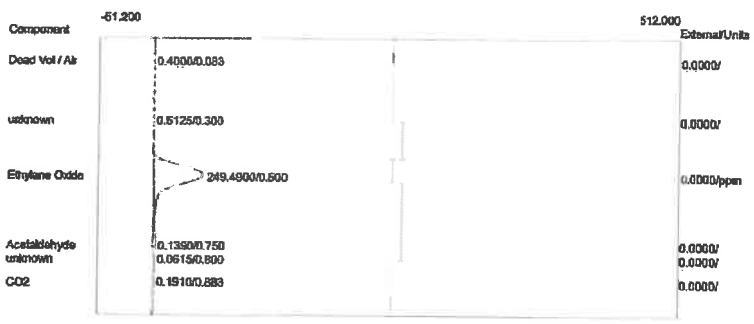
Component	Retention	Area	External	Units
Dead Vol / Air	0.100	20.0360	0.0000	
Ambient H2O	0.383	146.5610	0.0000	
		166.5970	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 09:50:51
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-C01.CHR (c:\peak359)
Sample: 100 ppm std
Operator: D. Kremer



Component	Retention	Area	External	Units
Dead Vol / Air	0.066	0.1770	0.0000	
Ethylene Oxide	0.466	39.2725	0.0000	ppm
		39.4495	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 09:50:51
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-C01.CHR (c:\peak359)
Sample: 100 ppm std
Operator: D. Kremer

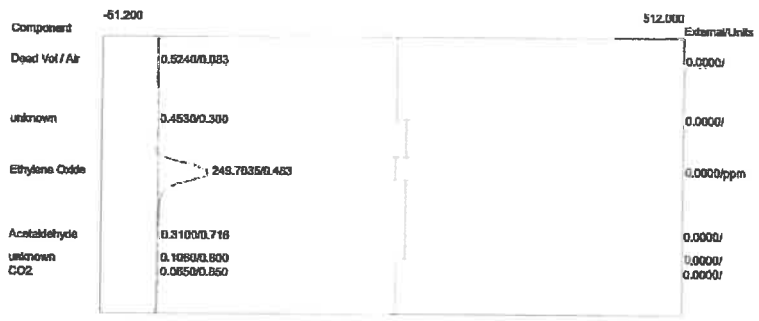


Component	Retention	Area	External	Units
Dead Vol / Air	0.083	0.4000	0.0000	
Ethylene Oxide	0.500	249.4900	0.0000	ppm
Acetaldehyde	0.750	0.1390	0.0000	
CO2	0.883	0.1910	0.0000	
		250.2200	0.0000	

Lab name: ECSI
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 09:54:38
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-C02.CHR (c:\peak359)
Sample: 100 ppm std
Operator: D. Kremer

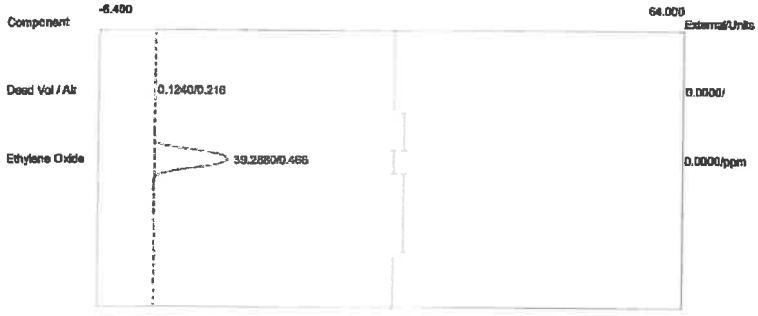
Component	Retention	Area	External	Units
Dead Vol / Air	0.050	0.1345	0.0000	
Ethylene Oxide	0.466	39.4295	0.0000	ppm
Acetaldehyde	0.566	0.1735	0.0000	
		39.7375	0.0000	

Lab name: ECSI
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 09:54:38
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-C02.CHR (c:\peak359)
Sample: 100 ppm std
Operator: D. Kremer



Component	Retention	Area	External	Units
Dead Vol / Air	0.083	0.5240	0.0000	
Ethylene Oxide	0.483	249.7035	0.0000	ppm
Acetaldehyde	0.716	0.3100	0.0000	
CO2	0.850	0.0650	0.0000	
		250.6025	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 09:58:20
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-C03.CHR (c:\peak359)
Sample: 100 ppm std
Operator: D. Kremer



Component	Retention	Area	External	Units
Dead Vol / Air	0.216	0.1240	0.0000	
Ethylene Oxide	0.466	39.2880	0.0000	ppm
		39.4120	0.0000	

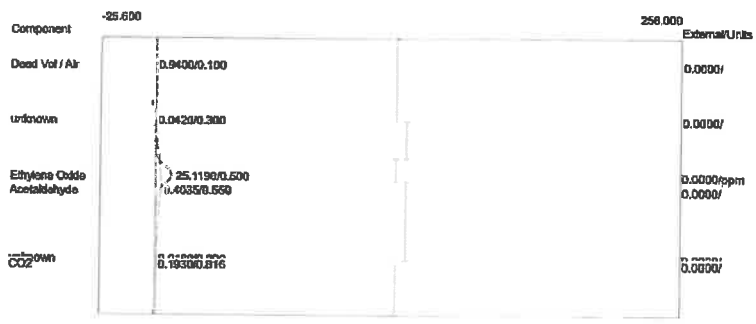
Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 09:58:20
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-C03.CHR (c:\peak359)
Sample: 100 ppm std
Operator: D. Kremer

Component	Retention	Area	External	Units
Dead Vol / Air	0.066	0.8390	0.0000	
Ethylene Oxide	0.483	249.3930	0.0000	ppm
Acetaldehyde	0.766	0.0615	0.0000	
CO2	0.883	0.1320	0.0000	
		250.4255	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 10:14:50
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-C04.CHR (c:\peak359)
Sample: 10.1 ppm std
Operator: D. Kremer

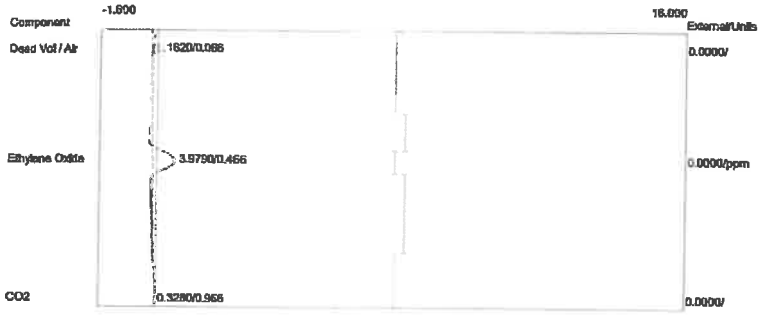
Component	Retention	Area	External	Units
Ethylene Oxide	0.466	3.9950	0.0000	ppm
		3.9950	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 10:14:50
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-C04.CHR (c:\peak359)
Sample: 10.1 ppm std
Operator: D. Kremer



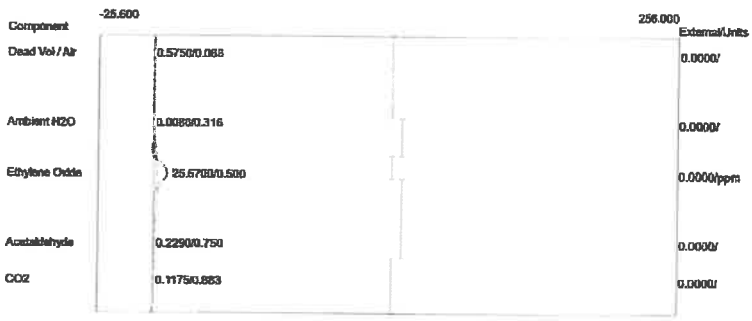
Component	Retention	Area	External	Units
Dead Vol / Air	0.100	0.9400	0.0000	
Ethylene Oxide	0.500	25.1190	0.0000	ppm
Acetaldehyde	0.550	0.4035	0.0000	
CO2	0.816	0.1930	0.0000	
		26.6555	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 10:19:14
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-C05.CHR (c:\peak359)
Sample: 10.1 ppm std
Operator: D. Kremer



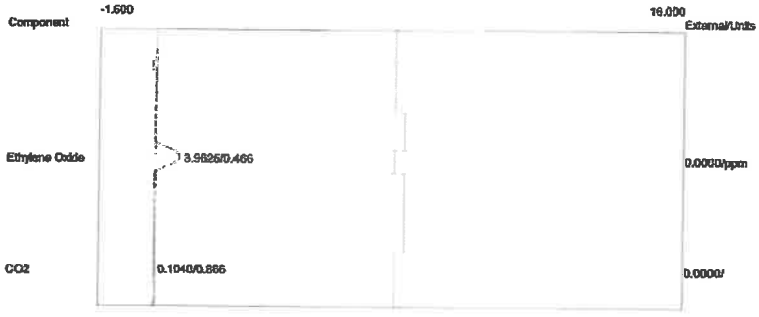
Component	Retention	Area	External	Units
Dead Vol / Air	0.066	0.1620	0.0000	
Ethylene Oxide	0.466	3.9790	0.0000	ppm
CO2	0.966	0.3260	0.0000	
		4.4670	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 10:19:14
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-C05.CHR (c:\peak359)
Sample: 10.1 ppm std
Operator: D. Kremer



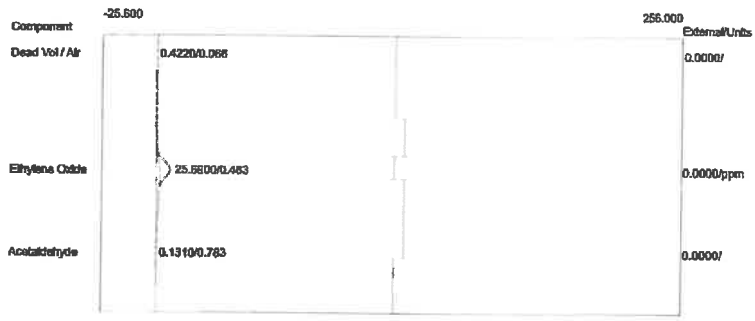
Component	Retention	Area	External	Units
Dead Vol / Air	0.066	0.5750	0.0000	
Ambient H2O	0.316	0.0080	0.0000	
Ethylene Oxide	0.500	25.5700	0.0000	ppm
Acetaldehyde	0.750	0.2290	0.0000	
CO2	0.883	0.1175	0.0000	
		26.4995	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 10:23:22
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-C06.CHR (c:\peak359)
Sample: 10.1 ppm std
Operator: D. Kremer



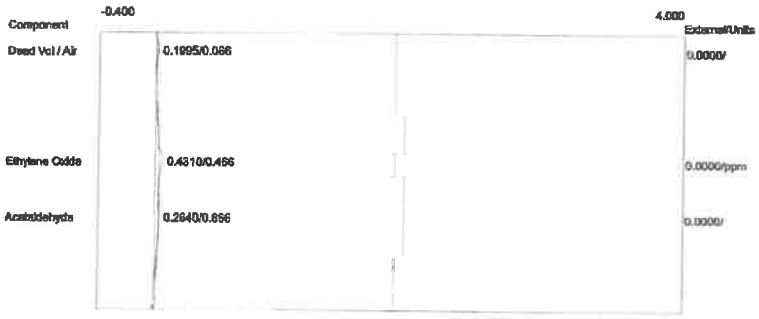
Component	Retention	Area	External	Units
Ethylene Oxide	0.466	3.9625	0.0000	ppm
CO2	0.866	0.1040	0.0000	
		4.0665	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 10:23:22
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-C06.CHR (c:\peak359)
Sample: 10.1 ppm std
Operator: D. Kremer



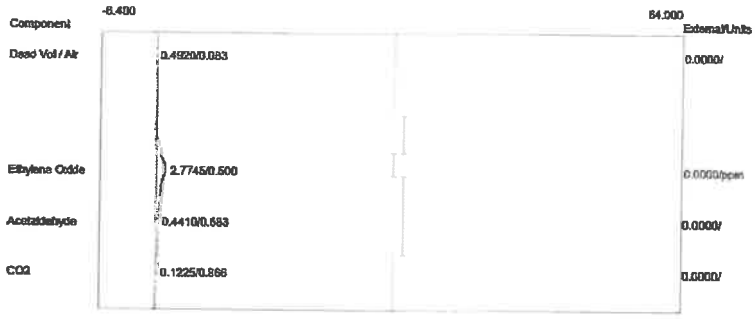
Component	Retention	Area	External	Units
Dead Vol / Air	0.066	0.4220	0.0000	
Ethylene Oxide	0.483	25.6900	0.0000	ppm
Acetaldehyde	0.783	0.1310	0.0000	
		26.2430	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 10:30:30
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-C07.CHR (c:\peak359)
Sample: 1.10 ppm std
Operator: D. Kremer



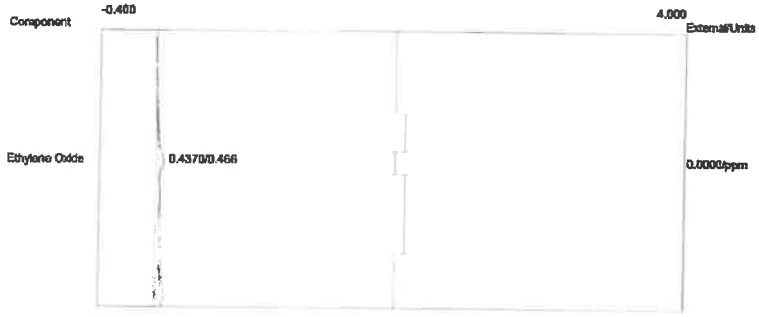
Component	Retention	Area	External	Units
Dead Vol / Air	0.066	0.1995	0.0000	
Ethylene Oxide	0.466	0.4310	0.0000	ppm
Acetaldehyde	0.666	0.2640	0.0000	
		0.8945	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 10:30:30
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-C07.CHR (c:\peak359)
Sample: 1.10 ppm std
Operator: D. Kremer



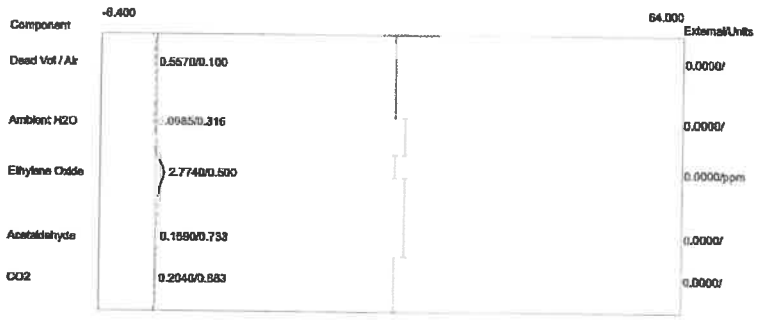
Component	Retention	Area	External	Units
Dead Vol / Air	0.083	0.4920	0.0000	
Ethylene Oxide	0.500	2.7745	0.0000	ppm
Acetaldehyde	0.683	0.4410	0.0000	
CO2	0.866	0.1225	0.0000	
		3.8300	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 10:34:48
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-C08.CHR (c:\peak359)
Sample: 1.10 ppm std
Operator: D. Kremer



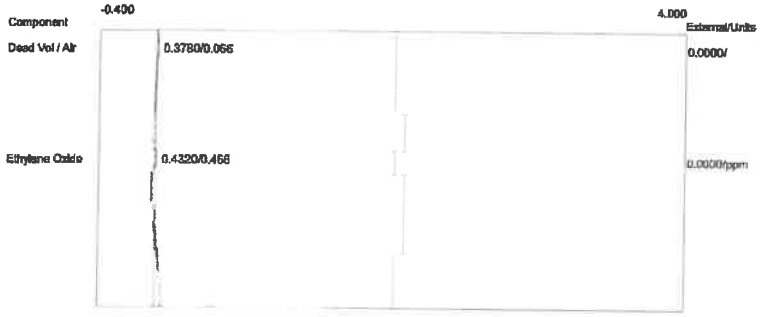
Component	Retention	Area	External	Units
Ethylene Oxide	0.466	0.4370	0.0000	ppm
		0.4370	0.0000	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 10:34:48
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-C08.CHR (c:\peak359)
Sample: 1.10 ppm std
Operator: D. Kremer



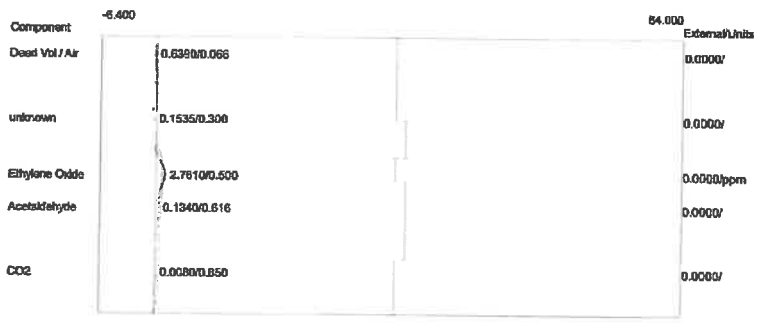
Component	Retention	Area	External	Units
Dead Vol / Air	0.100	0.5570	0.0000	
Ambient H2O	0.316	0.0985	0.0000	
Ethylene Oxide	0.500	2.7740	0.0000	ppm
Acetaldehyde	0.733	0.1690	0.0000	
CO2	0.883	0.2040	0.0000	
		3.8025	0.0000	

Lab name: ECSI
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 10:39:28
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-C09.CHR (c:\peak359)
Sample: 1.10 ppm std
Operator: D. Kremer



Component	Retention	Area	External	Units
Dead Vol / Air	0.066	0.3780	0.0000	
Ethylene Oxide	0.466	0.4320	0.0000	ppm
		0.8100	0.0000	

Lab name: ECSI
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 10:39:28
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-C09.CHR (c:\peak359)
Sample: 1.10 ppm std
Operator: D. Kremer



Component	Retention	Area	External	Units
Dead Vol / Air	0.066	0.6390	0.0000	
Ethylene Oxide	0.500	2.7610	0.0000	ppm
Acetaldehyde	0.616	0.1340	0.0000	
CO2	0.850	0.0080	0.0000	
		3.5420	0.0000	

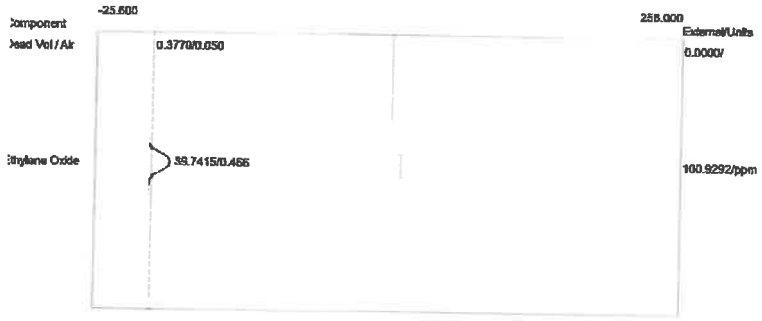
Lab name: ECSI
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 14:15:26
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-C14.CHR (c:\peak359)
Sample: 100 ppm Sample Line Bias
Operator: D. Kremer

Component	Retention	Area	External	Units
Dead Vol / Air	0.050	0.1620	0.0000	
Ambient H2O	0.316	0.5600	0.0000	
Ethylene Oxide	0.466	40.2225	102.1508	ppm
CO2	0.966	2.5210	0.0000	
		43.4655	102.1508	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: PreCal
Analysis date: 09/20/2018 14:07:47
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-C11.CHR (c:\peak359)
Sample: 100 ppm Sample Line Bias
Operator: D. Kremer

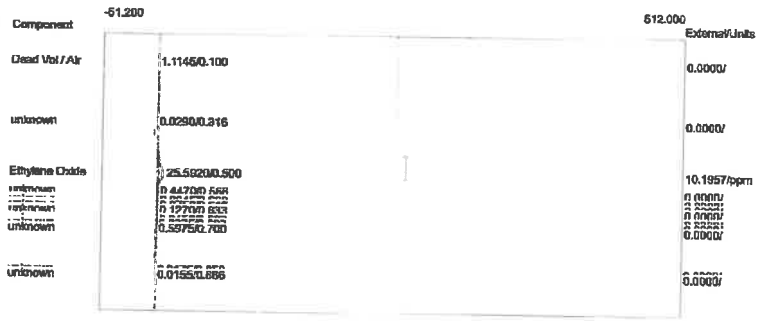
Component	Retention	Area	External	Units
Dead Vol / Air	0.083	3.4670	0.0000	
Ethylene Oxide	0.500	254.8000	101.5108	ppm
Acetaldehyde	0.750	0.2415	0.0000	
CO2	0.816	0.0980	0.0000	
		258.6065	101.5108	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: PostCal
Analysis date: 09/20/2018 17:55:27
Method: Direct Injection
Description: CHANNEL 1 - FID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto1-100.cpt
Data file: 1Ster2WB2018-C15.CHR (c:\peak359)
Sample: 100 ppm std sample line bias
Operator: D. Kremer



Component	Retention	Area	External	Units
Dead Vol / Air	0.050	0.3770	0.0000	
Ethylene Oxide	0.466	39.7415	100.9292	ppm
		40.1185	100.9292	

Lab name: ECSi
Client: Sterigenics - Willowbrook 2
Client ID: ~~Bmw359~~ PostCal
Analysis date: 09/20/2018 18:09:26
Method: Direct Injection
Description: CHANNEL 2 - PID
Column: 1% SP-1000, Carbopack B
Carrier: HELIUM
Temp. prog: eto-100.tem
Components: eto2-100.cpt
Data file: 2Ster2WB2018-C12.CHR (c:\peak359)
Sample: ~~AMF Outlet~~ 10 ppm std sample line bias
Operator: D. Kremer



Component	Retention	Area	External	Units
Dead Vol / Air	0.100	1.1145	0.0000	
Ethylene Oxide	0.500	25.5920	10.1957	ppm
		26.7065	10.1957	

APPENDIX J

Gas Certifications

ECSi

CERTIFIED WORKING CLASS

Single-Certified Calibration Standard

Scott Specialty Gases

600 CAJON BLVD., SAN BERNARDINO, CA 92411 Phone: 909-887-2571 Fax: 909-887-0549

CERTIFICATE OF ACCURACY: Certified Working Class Calibration Standard

Product Information
Project No.: 02-57164-001
Item No.: 02020001310TCL
P.O. No.: VBL – D. KREMER

Cylinder Number: CAL4448
Cylinder Size: CL
Certification Date: 20Apr2018

Customer

ECSI, INC
PO BOX 1498
SAN CLEMENTE, CA 92674

CERTIFIED CONCENTRATION

Component Name	Concentration (Moles)		Accuracy (+/-%)
ETHYLENE OXIDE	1.10	PPM	5
NITROGEN		BALANCE	

TRACEABILITY

Traceable To

Scott Reference Standard

APPROVED BY: MT DATE: 4-20-18

SPECIFICATIONS

Component Name	Requested Concentration (Moles)	Certified Concentration (Moles)	Blend Tolerance Result (+/- %)	Certified Accuracy Result (+/- %)
ETHYLENE OXIDE	1. PPM	1.10 PPM	10.0	5.00
NITROGEN	BAL	BAL		

TRACEABILITY

Traceable To
Scott Reference Standard

PHYSICAL PROPERTIES

Cylinder Size: CL

Pressure: 1200 PSIG
Expiration Date: 20Apr2020

SPECIAL HANDLING INSTRUCTIONS

Do not use or store cylinder at or below the stated dew point temperature. Possible condensation of heavier components could result. In the event the cylinder has been exposed to temperatures at or below the dew point, place cylinder in heated area for 24 hours and then roll cylinder for 15 minutes to re-mix.

Use of calibration standards at or below dew point temperature may result in calibration error.

COMMENTS

CERTIFIED WORKING CLASS

Single-Certified Calibration Standard

Scott Specialty Gases
00 CAJON BLVD., SAN BERNARDINO, CA 92411
Phone: 909-887-2571 Fax: 909-887-0549

CERTIFICATE OF ACCURACY: Certified Working Class Calibration Standard

Product Information
Project No.: 02-57164-003
Item No.: 02020001320TCL
P.O. No.: VBL – D. KREMER

Cylinder Number: CLM003232
Cylinder Size: CL
Certification Date: 20Apr2018

Customer

ECSI, INC
PO BOX 1498
SAN CLEMENTE, CA 92674

CERTIFIED CONCENTRATION

Component Name	Concentration (Moles)		Accuracy (+/-%)
ETHYLENE OXIDE	10.1	PPM	5
NITROGEN		BALANCE	

TRACEABILITY

Traceable To

Scott Reference Standard

APPROVED BY: MT MT DATE: 4-20-18

SPECIFICATIONS

Component Name	Requested Concentration (Moles)	Certified Concentration (Moles)	Blend Tolerance Result (+/- %)	Certified Accuracy Result (+/- %)
ETHYLENE OXIDE	10. PPM	10.1 PPM	1.0	5.00
NITROGEN	BAL	BAL		

TRACEABILITY

Traceable To
Scott Reference Standard

PHYSICAL PROPERTIES

Cylinder Size: CL

Pressure: 1200 PSIG
Expiration Date: 20Apr2020

SPECIAL HANDLING INSTRUCTIONS

Do not use or store cylinder at or below the stated dew point temperature. Possible condensation of heavier components could result. In the event the cylinder has been exposed to temperatures at or below the dew point, place cylinder in heated area for 24 hours and then roll cylinder for 15 minutes to re-mix.

Use of calibration standards at or below dew point temperature may result in calibration error.

COMMENTS

CERTIFIED WORKING CLASS

Single-Certified Calibration Standard

Scott Specialty Gases

00 CAJON BLVD., SAN BERNARDINO, CA 92411 Phone: 909-887-2571 Fax: 909-887-0549

CERTIFICATE OF ACCURACY: Certified Working Class Calibration Standard

Product Information
Project No.: 02-57164-004
Item No.: 02020001330TCL
P.O. No.: VBL – D. KREMER

Cylinder Number: CLM011385
Cylinder Size: CL
Certification Date: 20Apr2018

Customer

ECSI, INC
PO BOX 1498
SAN CLEMENTE, CA 92674

CERTIFIED CONCENTRATION

Component Name	Concentration (Moles)		Accuracy (+/-%)
ETHYLENE OXIDE	100.	PPM	5
NITROGEN		BALANCE	

TRACEABILITY

Traceable To

Scott Reference Standard

APPROVED BY: B - McCully
BLM

DATE: 4-20-18

SPECIFICATIONS

Component Name	Requested Concentration (Moles)		Certified Concentration (Moles)		Blend Tolerance Result (+/- %)	Certified Accuracy Result (+/- %)
ETHYLENE OXIDE	100.	PPM	100.	PPM	.0	5.00
NITROGEN		BAL		BAL		

TRACEABILITY

Traceable To
Scott Reference Standard

PHYSICAL PROPERTIES

Cylinder Size: CL

Pressure: 1300 PSIG
Expiration Date: 20Apr2020

Valve Connection: CGA 350

SPECIAL HANDLING INSTRUCTIONS

Do not use or store cylinder at or below the stated dew point temperature. Possible condensation of heavier components could result. In the event the cylinder has been exposed to temperatures at or below the dew point, place cylinder in heated area for 24 hours and then roll cylinder for 15 minutes to re-mix.

Use of calibration standards at or below dew point temperature may result in calibration error.

COMMENTS

CERTIFIED WORKING CLASS

Single-Certified Calibration Standard

Scott Specialty Gases
00 CAJON BLVD., SAN BERNARDINO, CA 92411
Phone: 909-887-2571 Fax: 909-887-0549

CERTIFICATE OF ACCURACY: Certified Working Class Calibration Standard

Product Information
Project No.: 02-57164-005
Item No.: 02020001340TCL
P.O. No.: VBL – D. KREMER

Cylinder Number: CLM002810
Cylinder Size: CL
Certification Date: 20Apr2018

Customer

ECSI, INC
PO BOX 1498
SAN CLEMENTE, CA 92674

CERTIFIED CONCENTRATION

Component Name	Concentration (Moles)		Accuracy (+/-%)
ETHYLENE OXIDE	1,000.	PPM	5
NITROGEN		BALANCE	

TRACEABILITY

Traceable To

Scott Reference Standard

APPROVED BY: B. McElroy
BLM

DATE: 4-20-18

SPECIFICATIONS

Component Name	Requested Concentration (Moles)		Certified Concentration (Moles)		Blend Tolerance Result (+/- %)	Certified Accuracy Result (+/- %)
ETHYLENE OXIDE	1,000.	PPM	1,000.	PPM	.0	5.00
NITROGEN		BAL		BAL		

TRACEABILITY

Traceable To
Scott Reference .Standard

PHYSICAL PROPERTIES

Cylinder Size: CL

Pressure: 1200 PSIG
Expiration Date: 20Apr2020

Valve Connection: CGA 350

SPECIAL HANDLING INSTRUCTIONS

Do not use or store cylinder at or below the stated dew point temperature. Possible condensation of heavier components could result. In the event the cylinder has been exposed to temperatures at or below the dew point, place cylinder in heated area for 24 hours and then roll cylinder for 15 minutes to re-mix.

Use of calibration standards at or below dew point temperature may result in calibration error.

COMMENTS

CERTIFIED WORKING CLASS

Single-Certified Calibration Standard

Scott Specialty Gases

00 CAJON BLVD., SAN BERNARDINO, CA 92411 Phone: 909-887-2571 Fax: 909-887-0549

CERTIFICATE OF ACCURACY: Certified Working Class Calibration Standard

Product Information
Project No.: 02-57164-006
Item No.: 02020001340TCL
P.O. No.: VBL – D. KREMER

Cylinder Number: CLM005787
Cylinder Size: CL
Certification Date: 20Apr2018

Customer

ECSI, INC
PO BOX 1498
SAN CLEMENTE, CA 92674

CERTIFIED CONCENTRATION

Component Name	Concentration (Moles)		Accuracy (+/-%)
ETHYLENE OXIDE	10,080.	PPM	5
NITROGEN		BALANCE	

TRACEABILITY

Traceable To

Scott Reference Standard

APPROVED BY: B. McCully BLM DATE: 4-20-18

SPECIFICATIONS

Component Name	Requested Concentration (Moles)		Certified Concentration (Moles)		Blend Tolerance Result (+/- %)	Certified Accuracy Result (+/- %)
ETHYLENE OXIDE	10,000.	PPM	10,080.	PPM	.8	5.00
NITROGEN		BAL		BAL		

TRACEABILITY

Traceable To
Scott Reference Standard

PHYSICAL PROPERTIES

Cylinder Size: CL

Pressure: 700 PSIG
Expiration Date: 20Apr2020

Valve Connection: CGA 350

SPECIAL HANDLING INSTRUCTIONS

Do not use or store cylinder at or below the stated dew point temperature. Possible condensation of heavier components could result. In the event the cylinder has been exposed to temperatures at or below the dew point, place cylinder in heated area for 24 hours and then roll cylinder for 15 minutes to re-mix.

Use of calibration standards at or below dew point temperature may result in calibration error.

COMMENTS

CERTIFICATE OF ANALYSIS

Customer Name:	ECSi, Inc.	**Cylinder Number:**	SA25925
Stock or Analyzer Tag Number:	N/A	**Product Class:**	Certified Standard
Customer Reference:	Verbal- Dan	**Cylinder - Contents[1]:**	28 CF @ 2000 PSI
MESA Reference:	104448	**Cylinder-CGA:**	A006-HP-BR/350
Date of Certification:	4/19/2018	**Analysis Method:**	GC-TCD/FID
Recommended Shelf Life:	2 Years	**Preparation Method:**	Gravimetric

Component	Requested Concentration[2]	Reported Concentration[2,3]
Ethylene Oxide	50 ppm	48.8 ppm
Nitrogen	Balance	Balance

Authorized Signature:

1. The fill pressure shown on the COA is as originally quoted. The fill pressure measured by the customer may differ from the fill pressure originally quoted due to temperature effects, compressibility of the individual components when blended together in the cylinder. gauge accuracy or reduction in content volume before shipping as a result of samples withdrawn for laboratory QC necessary to ensure product quality.
2. Unless otherwise stated, concentrations are given in molar units.
3. Vapor pressure mixes are blended at a sufficiently low pressure so as to eliminate phase separation under most low temperature conditions encountered during transport or storage. However, it is generally recommended that cylinders containing vapor pressure restricted mixes be placed on the floor in a horizontal position and rolled back and forth to improve homogeneity of the gas phase mixture before being put into service.

Analytical Gas Standards are prepared and analyzed using combinations of NIST traceable weights, SRM's provided by NIST, or internal gas standards that have been verified for accuracy using procedures published by the US-EPA. Pure gases are analyzed and certified for purity using minor component Analytical Gas Standards prepared according to the methods specified above. Balances are calibrated to NIST test weights covered by NIST test number 822/256175/96. Reference Certification #'s: 163/W, 830/N and 3280. Calibration methods are in conformance with MIL-STD 45662A.

MESA Specialty Gases & Equipment
division of MESA International Technologies, Inc.
3619 Pendleton Avenue, Suite C ♦ Santa Ana, California 92704 ♦ USA
TEL: 714-434-7102 ♦ FAX: 714-434-8006 ♦ E-mail: mail@mesagas.com
On-line Catalog at www.mesagas.com

APPENDIX K

Limit of Detection

ECSi

Detection Limit Study

Step 1 : Prepare and analyze at least seven standards prepared at or near the estimated detection limit

Step 2 : Record and calculate the standard deviation of the replicate measurements.

Analysis Number	1	2	3	4	5	6	7	8	9	10
Result	1.007	1.011	1.015	1.01	1.071	1.071	1.067			

Calculated Standard Deviation = 0.0316

Step 3 : Determine the Method Detection Limit (MDL) by mulitplying the student T value appropriate for 99% confidence level and the standard deviation estimate with in n-1 degrees of freedom

Number of Replicates	7	8	9	10
T-values	3.143	2.998	2.896	2.821

Method Detection Limit: = 0.10

Wagner, Kevin

From: Hoffman, Kathy
Sent: Tuesday, September 25, 2018 8:42 AM
To: Wagner, Kevin
Subject: FW: MDL calculations and additional information.
Attachments: Detection Limit Master Spreadsheet.xls

From: Shappley, Ned [mailto:Shappley.Ned@epa.gov]
Sent: Monday, September 24, 2018 12:02 PM
To: Hoffman, Kathy; dankremer@ecsi1.com
Cc: Sieffert, Margaret; Mattison, Kevin; Merrill, Raymond; Johnson, Steffan
Subject: MDL calculations and additional information.

Dan/Kathy,

As we discussed on site, attached is the spreadsheet (Note, this is not an official EPA spreadsheet) I used to determine the MDL (i.e., LOD) for the testing last week at Sterigenics. It is important to include all raw data associated with this study as well as a discussion of the procedures used. The reference for how MDL studies should be performed can be found in Section 15.2 of Method 301 (40 CFR Part 63), which links you to 40 CFR Part 136, Appendix B (see below). In this instance, I am making the recommendation to Illinois EPA to accept this MDL study with just spiked samples and collected over a shorter time period.

Based on the 7 replicate values I calculated using the low calibration response, in lieu of reporting a ND, you should report a <0.10 ppm for the measured concentration. It is important to use this MDL value when calculating the DRE. Going forward you should consider repeating the MDL for each test program or include a MDL verification step to ensure that your system is capable of measuring at these low-levels. For future MDL studies, it is strongly suggested you develop an MDL using a similar matrix (i.e., in air) as opposed to a calibration gas cylinder. I suggest filling a Tedlar bag with carbon-free air and injecting a concentration of EtO into the bag targeting a concentration in the Tedlar Bag of approximately 0.3 to 0.5 ppm. This type of evaluation would best replicate the sample matrix as measured by the GC.

Additional Information:

Going forward, it is important to use the procedures that were utilized during the Sterigenics for future tests, making sure to 1) verify the sampling testing locations meet all Method 1 criteria, 2) performing all required velocity traverses as required by the method, 3) use of heated sampling system (Method 18 – Section 8.2.2.1.1 and 8.2.2.1.2) to prevent moisture or organic condensation, 4) perform a successful recovery study for direct interface sampling (Method 18 – Section 8.4.1) to verify the efficacy of the sampling system, and 5) to select calibration standards that bracket the sample concentrations (Method 18 – Section 8.2.4.3). These are not recommendations, they are requirements of the method and failure to follow these procedures could be grounds for a regulatory authority to invalidate a test.

Please let me know if you have any questions,

Ned Shappley

40 CFR Part 136, Appendix B

....

(a) Select a spiking level, typically 2—10 times the estimated MDL in Section 1. Spiking levels in excess of 10 times the estimated detection limit may be required for analytes with very poor recovery (e.g., for an analyte with 10% recovery, spiked at 100 micrograms/L, with mean recovery of 10 micrograms/L; the calculated MDL may be around 3 micrograms/L. Therefore, in this example, the spiking level would be 33 times the MDL, but spiking lower may result in no recovery at all).

(b) Process a minimum of seven spiked samples and seven method blank samples through all steps of the method. The samples used for the MDL must be prepared in at least three batches on three separate calendar dates and analyzed on three separate calendar dates. (Preparation and analysis may be on the same day.) Existing data may be used, if compliant with the requirements for at least three batches, and generated within the last twenty four months. The most recent available data for method blanks and spiked samples must be used. Statistical outlier removal procedures should not be used to remove data for the initial MDL determination, since the total number of observations is small and the purpose of the MDL procedure is to capture routine method variability. However, documented instances of gross failures (e.g., instrument malfunctions, mislabeled samples, cracked vials) may be excluded from the calculations, provided that at least seven spiked samples and seven method blanks are available. (The rationale for removal of specific outliers must be documented and maintained on file with the results of the MDL determination.)

.....

(ii) Compute the MDL_s (the MDL based on spiked samples) as follows:
$MDL_S = t_{(n-1,\ 1-\alpha\ =\ 0.99)} S_s$
Where:
MDL_s *= the method detection limit based on spiked samples*
$t_{(n-1,\ 1-\alpha\ =\ 0.99)}$ *= the Student's t-value appropriate for a single-tailed 99th percentile t statistic and a standard deviation estimate with n-1 degrees of freedom. See Addendum Table 1.*
S_s *= sample standard deviation of the replicate spiked sample analyses.*

Ned Shappley | USEPA|OAQPS|AQAD|Measurement Technology Group
109 TW Alexander Drive (E143-02) | Research Triangle Park, NC 27711
email: shappley.ned@epa.gov | Phone (919)541-7903

APPENDIX L

Permits/Protocols

ECSi

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217) 782-3397
BRUCE RAUNER, GOVERNOR ALEC MESSINA, DIRECTOR

217/785-1705

CONSTRUCTION PERMIT
NESHAP SOURCE

PERMITTEE

Sterigenics US, LLC
Attn: Laura Hartman, EHS Manager
2015 Spring Road, Suite 650
Oak Brook, Illinois 60523

Application No.: 18060020 I.D. No.: 043110AAC
Applicant's Designation: Date Received: June 11, 2018
Subject: Control of the Backvents of the Sterilization Chambers
Date Issued: June 26, 2018
Location: 7775 Quincy and 830 Midway, Willowbrook, DuPage County

This Permit is hereby granted to the above-designated Permittee to CONSTRUCT emission source(s) and/or air pollution control equipment consisting of control of the backvents of the sterilization chambers, as described in the above-referenced application. This Permit is subject to standard conditions attached hereto and the following special condition(s):

1. Introduction

   a. This permit authorizes control of the existing backvents of the five sterilization chambers (SC-1, SC-2, SC-3, SC-4 and SC-5) at Sterigenic's Willowbrook facilities using the existing control systems that control emissions of ethylene oxide from the vacuum pumps and from aeration.

   b. This permit does not authorize changes to the sterilization chambers or other emission units at the source that would increase their capacity or emissions.

   c. For purposes of this permit, the existing sterilization chambers after their backvents are also connected to control systems are referred to as the "affected units."

2. Existing Requirements

   This permit does alter established requirements for the affected units, (i.e., applicable emission standards and requirements for testing, monitoring, recordkeeping and reporting), as identified in Sections 4.1 and 4.2 of the Clean Air Act Permit Program (CAAPP) permit for the source, Permit No. 95120085, issued June 8, 2015. In particular, the affected units will continue to be subject to federal National Emission Standards for Hazardous Air Pollutants (NESHAP) for Ethylene Oxide Emissions from Sterilization Facilities, 40 CFR 63 Subpart O.

3. Non-applicability Provisions

This permit is issued based on this project not constituting a major modification for purposes of the state rules for Major Stationary Sources Construction and Modification (MSSCAM), 35 IAC Part 203. This is because this project is an emission reduction project that will reduce emissions of volatile organic material.

4. Good Air Pollution Control Practices

At all times, the Permittee shall maintain and operate the affected units and associated air pollution control systems in a manner consistent with good air pollution control practices for minimizing emissions.

5. Notification

The Permittee shall notify the Illinois EPA within 30 days after completion of this project. This notification shall include the date that the backvent on each affected unit is first controlled.

6. Testing

a. Within 180 days of completion of this project, for the affected units, the Permittee shall perform performance testing in accordance with 40 CFR 63.365 and 63.7. The Permittee shall submit applicable notifications and reports for this testing as required by 40 CFR 63.7, 63.360, 63.365 and 63.366.

b. The following USEPA methods and procedures shall be used for testing, unless another USEPA method is approved by the Illinois EPA:

Flowrate	Method 2, 2A, 2B, 2C or 2D
Oxygen (O_2)/Carbon Dioxide (CO_2)	Method 3A or 3B
Moisture	Method 4 or 320
Ethylene Oxide/Propylene Oxide	Method 18 or 320

c. The Permittee shall submit a written test plan to the Illinois EPA for this testing and if a significant change in the procedures for this testing is planned from the procedures followed in the previous test. This plan shall be submitted at least 30 days prior to the actual date of testing and include the following information as a minimum:

i. A description of the planned test procedures.

ii. The person(s) who will be performing sampling and analysis and their experience with similar tests.

iii. The specific conditions under which testing will be performed, including a discussion of why these conditions will be representative of maximum emissions and the means or manner by which the operating parameters for the emission unit and any control equipment will be determined.

iv. The specific determinations of emissions and operation that are intended to be made, including sampling and monitoring locations.

v. The test method(s) that will be used, with the specific analysis method, if the method can be used with different analysis methods.

d. The Permittee shall notify the Illinois EPA prior to conducting these measurements to enable the Illinois EPA to observe testing. Notification for the expected date of testing shall be submitted a minimum of 30 days prior to the expected date. Notification of the actual date and expected time of testing shall be submitted a minimum of 5 working days prior to the actual date of the test. The Illinois EPA may accept shorter advance notice if it does not interfere with the Illinois EPA's ability to observe testing.

e. Copies of the Final Report(s) for these tests shall be submitted to the Illinois EPA within 30 days after the test results are compiled and finalized but no later than 60 days after completion of sampling. The Final Report shall include as a minimum:

i. General information, i.e., date of test, names of testing personnel, and names of Illinois EPA observers.

ii. A summary of results, e.g., VOM emissions, pounds.

iii. A detailed description of operating conditions of the emission unit(s) during testing, including:

A. Process information, i.e., mode(s) of operation, process rate, e.g. fuel or raw material consumption.

B. Control equipment information, i.e., equipment condition and operating parameters during testing.

C. A discussion of any preparatory actions taken, i.e., inspections, maintenance and repair.

iv. Description of test method(s), including description of sampling points, sampling train, analysis equipment, and test schedule.

v. Data and calculations, including copies of all raw data sheets and records of laboratory analyses, sample calculations, and data on equipment calibration.

vi. Conclusions.

f. The Permittee shall retain copies of emission test reports for at least three years beyond the date that an emission test is superseded by a more recent test.

7. Authorization to Operate

The Permittee may operate the affected units with backvents ducted to the existing control systems pursuant to this construction permit until the CAAPP permit for the source is revised to address this project. This condition supersedes Standard Condition 6.

Please note that the Illinois EPA has not acted in this permit on Sterigenic's request for enforceable limits on the operation and emissions of its Willowbrook facilities so that this source is not a major source under relevant air pollution control regulations. The Illinois EPA is processing that request as a separate application.

If you have any questions on this permit, please contact Daniel Rowell at 217/558-4368.

Raymond E. Pilapil
Manager, Permit Section
Bureau of Air

REP:DBR:jlp

DBR
6/24/18

STATE OF ILLINOIS
ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF AIR POLLUTION CONTROL
P. O. BOX 19506
SPRINGFIELD, ILLINOIS 62794-9506

STANDARD CONDITIONS FOR CONSTRUCTION/DEVELOPMENT PERMITS ISSUED BY THE ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

July 1, 1985

The Illinois Environmental Protection Act (Illinois Revised Statutes, Chapter 111-1/2, Section 1039) authorizes the Environmental Protection Agency to impose conditions on permits which it issues.

The following conditions are applicable unless superseded by special condition(s).

1. Unless this permit has been extended or it has been voided by a newly issued permit, this permit will expire one year from the date of issuance, unless a continuous program of construction or development on this project has started by such time.

2. The construction or development covered by this permit shall be done in compliance with applicable provisions of the Illinois Environmental Protection Act, and Regulations adopted by the Illinois Pollution Control Board.

3. There shall be no deviations from the approved plans and specifications unless a written request for modification, along with plans and specifications as required, shall have been submitted to the Agency and a supplemental written permit issued.

4. The Permittee shall allow any duly authorized agent of the Agency upon the presentation of credentials, at reasonable times:

   a. to enter the Permittee's property where actual or potential effluent, emission or noise sources are located or where any activity is to be conducted pursuant to this permit,

   b. to have access to and copy any records required to be kept under the terms and conditions of this permit,

   c. to inspect, including during any hours of operation of equipment constructed or operated under this permit, such equipment and any equipment required to be kept, used, operated, calibrated and maintained under this permit,

   d. to obtain and remove samples of any discharge or emission of pollutants, and

   e. to enter and utilize any photographic, recording, testing, monitoring or other equipment for the purpose of preserving, testing, monitoring, or recording any activity, discharge, or emission authorized by this permit.

5. The issuance of this permit:

   a. shall not be considered as in any manner affecting the title of the premises upon which the permitted facilities are to be located,

   b. does not release the Permittee from any liability for damage to person or property caused by or resulting from the construction, maintenance, or operation of the proposed facilities,

   c. does not release the Permittee from compliance with the other applicable statues and regulations of the United States, of the State of Illinois, or with applicable local laws, ordinances and regulations,

   d. does not take into consideration or attest to the structural stability of any units or parts of the project, and

e. in no manner implies or suggests that the Agency (or its officers, agents or employees) assumes any liability, directly or indirectly, for any loss due to damage, installation, maintenance, or operation of the proposed equipment or facility.

6. a. Unless a joint construction/operation permit has been issued, a permit for operation shall be obtained from the Agency before the equipment covered by this permit is placed into operation.

   b. For purposes of shakedown and testing, unless otherwise specified by a special permit condition, the equipment covered under this permit may be operated for a period not to exceed thirty (30) days.

7. The Agency may file a complaint with the Board for modification, suspension or revocation of a permit:

   a. upon discovery that the permit application contained misrepresentations, misinformation or false statements or that all relevant facts were not disclosed, or

   b. upon finding that any standard or special conditions have been violated, or

   c. upon any violations of the Environmental Protection Act or any regulation effective thereunder as a result of the construction or development authorized by this permit.

From: "Armitage, Julie" <Julie.Armitage@Illinois.gov>
Date: September 7, 2018 at 6:34:23 PM CDT
To: "Hoffman, Kathy" <KHoffman@sterigenics.com>
Cc: "Mattison, Kevin" <Kevin.Mattison@Illinois.gov>

By this email, at your request, and to facilitate the shared goal of expedited emissions testing, the Bureau of Air provides notice that it is waiving the timeframe for test plan submittal (30 days prior to testing – condition 6c) and the timeframe for notification of expected and actual test dates (30 and 5 days, respectively – condition 6d) under construction permit No. 18060020 issued June 26, 2018. Also, the Bureau provides notice that, after review and consultation with the USEPA, it is accepting the protocol received August 28, 2018, and supplemented September 7, 2018, conditioned upon the testing scheduled for September 8th, being performed in accordance with USEPA reference methods and supported by a detailed final report that evidences the validity of the test, adherence to reference methods, and compliance with all relevant permit terms.

Should you have comments or questions regarding this matter, pleased direct them to my attention or to that of Kevin Mattison of my staff who will be present for the September 8th testing.

Sterigenics®
A Sotera Health company

September 7, 2018 Sent via email

Julie Armitage
Illinois Environmental Protection Agency
Bureau of Air
1021 North Grand Avenue East
Springfield, Illinois 62702

Kevin Mattison
Illinois Environmental Protection Agency
Bureau of Air / Compliance Section
9511 Harrison Street
Des Plaines, IL 60016

Re: Waiver Request of Construction Permit Test Notification Requirements, and Additional Test Protocol Information for Sterigenics Willowbrook I and II Facilities
Facility I.D. No: 043110AAC

Ms. Armitage and Mr. Mattison:

In our recent conversations, we discussed our shared interest in conducting performance testing of the Willowbrook facilities' control equipment as quickly as possible after recently tying in our sterilization chamber backvents into each facility's existing emission control equipment. This letter formally requests IEPA's waiver of the 30 and 5 day performance test notification requirements found in the project's Construction Permit (Application No. 18060020), at Conditions 6 c. and 6 d. If the waiver of notification requirements is granted, then we would plan to commence performance testing beginning in the morning on Saturday, September 8 at approximately 7:00am at Willowbrook I, 7775 Quincy Street. Testing at Willowbrook II will commence at approximately noon.

This letter also provides additional information regarding the previously submitted test protocol we submitted in our last letter. Based on guidance from Mr. Mattison, this information will serve to provide further details about the planned test procedures and how test results are to be generated. With this additional information, we also request that IEPA grant its approval of the updated test protocol.

Please contact me to further discuss this matter. You can reach me at 630-928-1771 or email: kwagner@sterigenics.com.

Regards,

Kevin Wagner
Director, EH&S

Enclosures:

Sterigenics International LLC
2015 Spring Road, Suite 650 • Oak Brook, IL 60523
Tel 630.928.1700 • Fax 630.928.1701 • www.sterigenics.com

Sterigenics®
A Sotera Health company

Test Protocol Addendum for both Willowbrook I and Willowbrook II

2.0 EQUIPMENT

Process parameters for both AAT emission control devices will be measured prior to testing. One measurement of the scrubber would be representative of scrubber conditions throughout the testing. Based on the total volume of the scrubber liquor, it isn't anticipated that an appreciable change in liquor level or pH will occur over the course of testing. In accordance with the site's air permit the scrubber tank level will be measured along with the liquor pH.

3.0 TESTING

Once a sterilization chamber cycle ends, our process requires the chamber door to be partially opened for 15 minutes which vents the EO in the chamber to reduce levels in the chamber and exposure to employees. The 15-minute duration ensures the highest concentration of EO is removed from the chamber prior to unloading the product. During this venting, EO exhausts thru the backvent and to the AAT scrubber. In accordance with our procedures, workers are not allowed to enter or unload the chamber until the 15-minute time period has passed. Once the 15-minutes has passed, the product is unloaded to the aeration room.

The Willowbrook facility utilizes different sterilization cycles based on FDA validated cycles. The EO concentration in the chamber prior to the backvent phase can vary. Therefore, the higher ending concentrations will represent the highest amount of EO exhausted thru the backvents to the AAT scrubber.

In order to meet Condition 6 of the Construction Permit, each test run will be completed on the backvents using freshly sterilized product from one chamber for a 15-minute duration, for a total of three test runs at each facility. The emission testing will use chambers with higher ending EO concentrations for testing. Each test interval will test the first 15-minutes the backvent is opened and exhausted to the scrubber. Once the 15 minutes ends, product will be unloaded from the chamber and placed into the aeration rooms which are continuously vented to the same AAT scrubber throughout the test.

Recording data

Sterigenics will record process data during the performance testing to identify which chamber was utilized and the sterilization cycle number for each test. This process data will be summarized in a table which will be provided in the final report. In addition to the process data collection, Sterigenics will record pH and scrubber liquor level of the AAT scrubber prior to the test. This information will also be

furnished with the process data in the final report. Due to the AAT scrubber size and design, these parameters do not change significantly during the course of a day which exceeds the performance testing duration.

SECTION 5.0 TEST METHOD REFERENCE

The protocol indicated the CO2/O2 will not be measured, rather the stack will be assumed to be ambient air. The assumed molecular weight of the stack gas will be 29.

5.2 VOLUMETRIC FLOW MEASUREMENT

Method 2C will be utilized to test volumetric flow. The sample port used for the Method 18 inlet and outlet will be used for Method 2C. Please see attached Figure 1 for a drawing of the test locations in accordance with USEPA Method 1 or 1a. The absence of cyclonic flow will be verified during the test program.

5.4 SAMPLE TRANSPORT

In addition to the description of the sample transport in the protocol, the lines used for testing will be heated above 110°C. Source gas will be pumped to the GC with a response time of 5-10 seconds.

5.7 CALIBRATIONS

Calibration will be performed in triplicate prior to and at the end of each test day. Limit of detection will be determined.

6.0 TEST SCENARIO

As discussed above, backvent testing will be performed during normal process load conditions, with freshly sterilized product in the sterilization chambers. Three test runs will be conducted in series to verify the performance of the emission-control system.

Sterilization chamber cycles can range from 8 – 12 hours. Sterigenics will schedule three chambers to end the sterilization cycle to allow for the three test runs to run consecutively, however, due to the range in cycle time, it may be necessary to wait for the chamber cycle to end prior to beginning the subsequent testing.

The sample testing will begin at approximately 7:00 am on Saturday, September 8, 2018. The equipment will be set up Friday evening. Calibration of the chromatograph system will be completed prior to beginning the test at Willowbrook 1 and then again prior to beginning the test at Willowbrook 2.

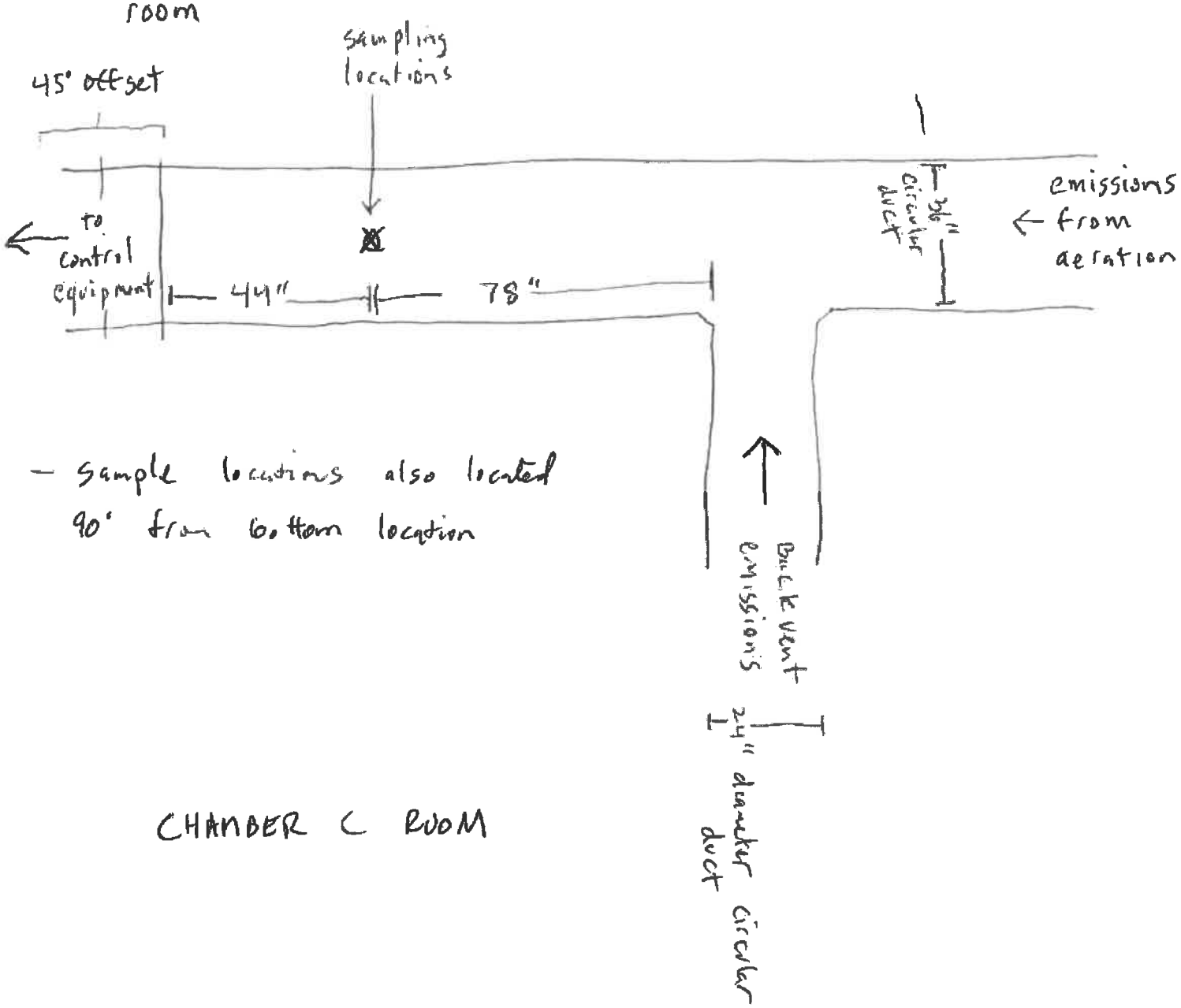
Sterigenics
A Sotera Health company

Test Scenario Time Line

	Sequence for each facility	**Method/Reference**
	Sample port locations established	Method 1
	3-point calibration performed in triplicate.	Method 18
	Obtain meteorological data for sampling time. Conduct calculation based on Method 4.	Method 4
SAMPLE 1	Flow traverse of inlet and outlet conducted to establish measurement centroid, confirm absence of cyclonic flow.	Method 2
7:00 am	Chamber door opened, actuator switch activates backvent	N/A
	First sample initiated	Method 18
	Samples at inlet and outlet taken approximately every 1-minute for a total of 15-minutes	Method 18
	Flow monitoring sampled approximately every 1-minute.	
	Recovery study performed	Method 18
Each sample run will follow the same steps as sample 1		
End of 3 samples	Post calibration	

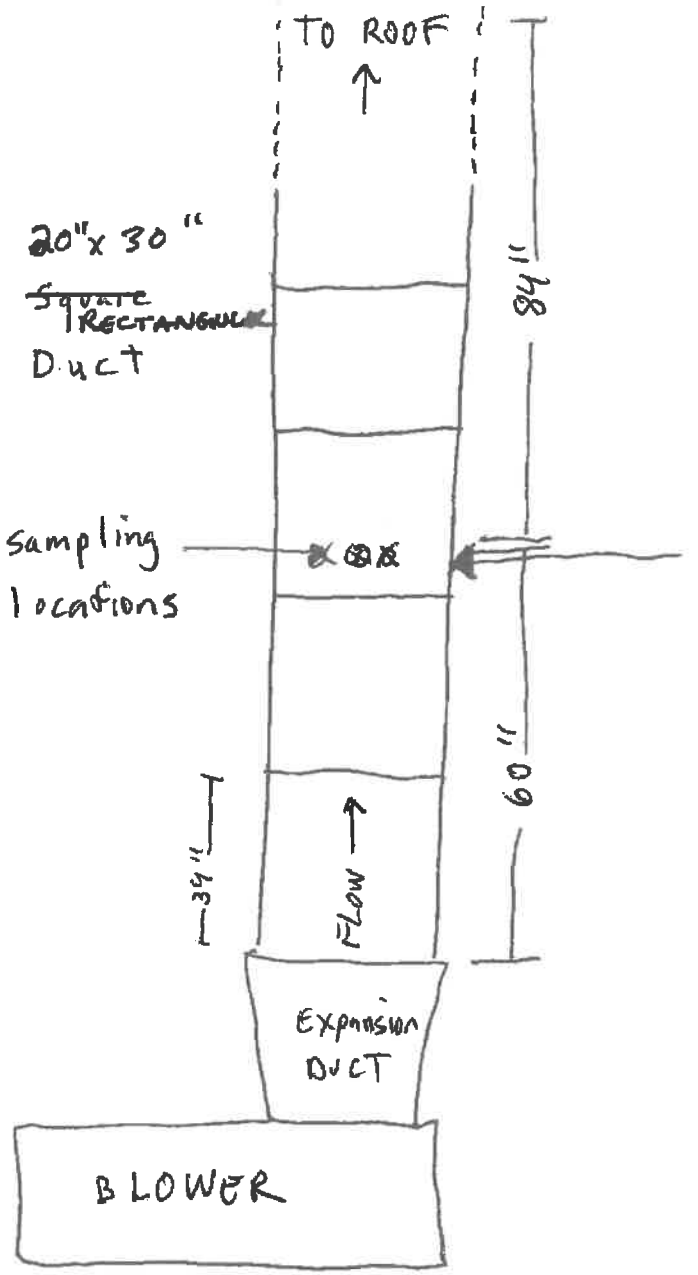
WB I INLET TEST LOCATION

- view is looking above at ceiling of chamber C room



- sample locations also located 90° from bottom location

WB I OUTLET TEST LOCATION

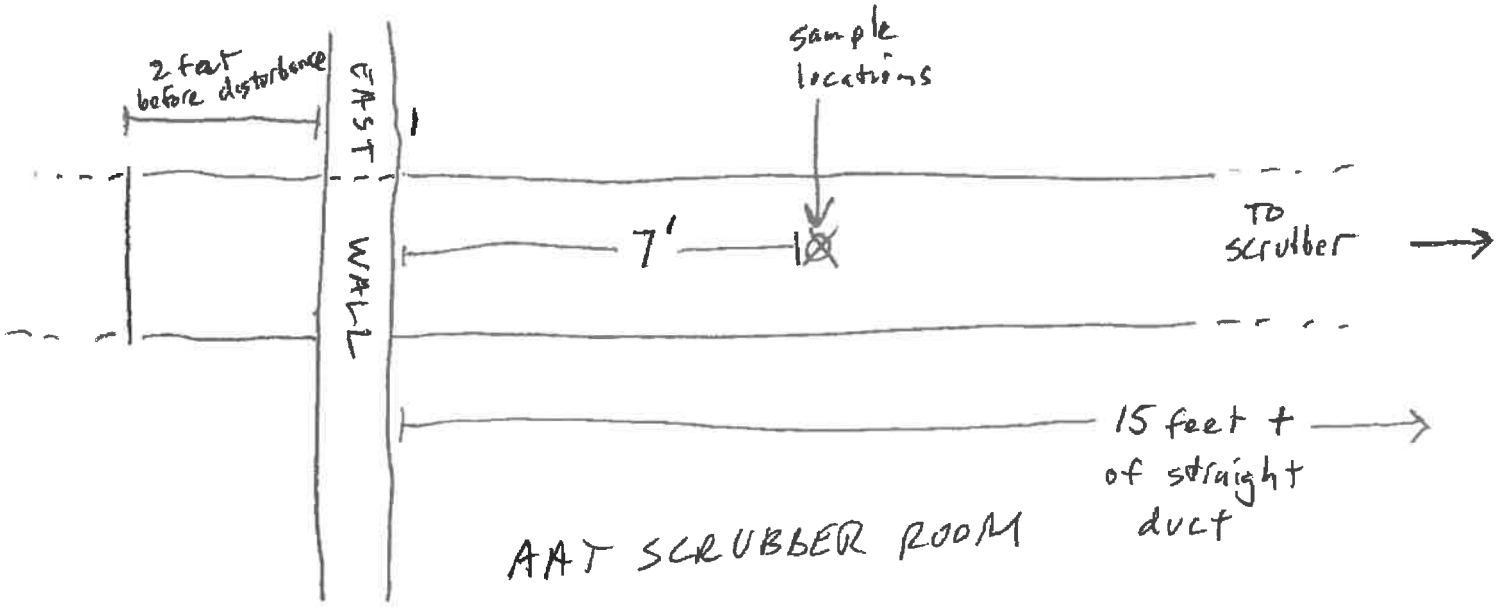


- Main stretch of ducting is 20" x 30" ~~square~~ rectangular duct
- Sample points are located 84" ~~from~~ below top-most disturbance and 60" above lowest disturbance

AAT DRYBED ROOM

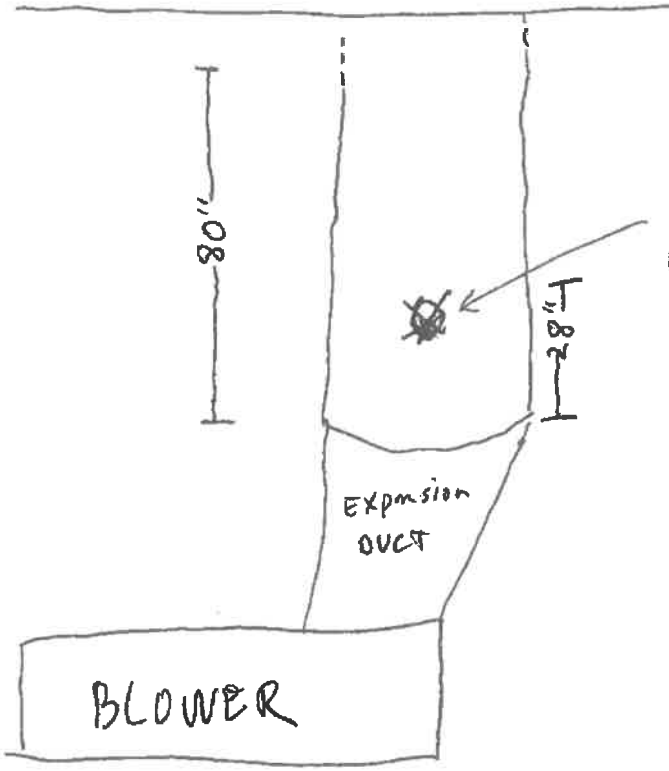
WB II INLET TEST LOCATION

- View is looking up at ceiling of AAT Scrubber Room



- sample locations also located 90' from bottom location.

WB II OUTLET TEST LOCATION



- 28" diameter circular duct
- Sample locations also located 90° from front location

AAT DRYBED ROOM

* Sample point will be located in straight run. Verified to meet Method prior to test.

TEST PROTOCOL FOR
AIR POLLUTION SOURCE TESTING
OF AN ETHYLENE OXIDE EMISSION-CONTROL SYSTEM
OPERATED BY STERIGENICS US, LLC.
AT ITS WILLOWBROOK II, ILLINOIS FACILITY

Submitted to:

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
1021 North Grand Avenue East
Springfield, Illinois 62794

Submitted by:

STERIGENICS US, LLC.
830 Midway Drive
Willowbrook, Illinois 60521

I.D. Number 043110AAC

Prepared by:

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Prepared on:

August 24, 2018

ECSi

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TEST DATE

September 20-21, 2018

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TABLE OF CONTENTS

ECSi

1.0 INTRODUCTION

ECSi, Inc. proposes to conduct air pollution source testing of the ethylene oxide (EtO) emission control system operated by Sterigenics US, LLC. at their Willowbrook II facility, located at 830 Midway Drive. The device to be tested is the two stage AAT Safe Cell packed tower scrubber/dry bed reactor emission-control system, which is used to control emissions from four sterilizer vacuum pumps, four sterilizer backvents and two aeration rooms. The purpose of the testing program will be to demonstrate compliance with backvent emission control requirements and the conditions established in the Air Quality Permit granted to Sterigenics by the Illinois Environmental Protection Agency (IEPA).

We have specialized exclusively in the performance of ethylene oxide source testing and leak testing since 1992, and are the nationally recognized expert in the field. When the current ethylene oxide emissions regulations were being implemented, we worked closely with the California Air Resources Board (CARB) and USEPA to help develop the currently used testing methodology.

2.0 EQUIPMENT

At Willowbrook I, sterilizer backvent emissions are controlled by:

- One two-stage Advanced Air Technologies Safe Cell emission-control system, comprised of a packed-tower chemical scrubber (SC1), equipped with a packed reaction/interface column, a scrubber fluid recirculation system, and a scrubber fluid reaction/storage tank, and a dry bed reactor/scrubber (SC2), comprised of a bank of solid-bed reaction vessels, connected in parallel, installed downstream of SC1 and upstream of a dedicated blower exhaust system.

3.0 TESTING

EtO source testing will be conducted in accordance with the procedures outlined in USEPA CFR40, Part 63.365, using USEPA Method 18 as specified. EtO emissions monitoring will be conducted simultaneously at the inlet and outlet of the Safe Cell System (the inlet of SC1 and the outlet of SC2) during the entire duration of the backvent phase of one of the four sterilizers. A total of three backvent-phase test runs will be performed.

During the backvent phase, EtO emissions at the inlet and the outlet of the Safe Cell System will be determined using direct source sample injection into a gas chromatograph (GC). All testing will be conducted during normal process load conditions. All backvent testing will be performed with freshly sterilized product in the sterilizer. The testing program will be conducted in accordance with the procedures outlined in the following sections.

4.0 RULE/COMPLIANCE REQUIREMENTS

The EtO gas-sterilization system at the Willowbrook I facility is being tested to demonstrate compliance with EPA requirements, as specified in the IEPA Air Quality Permit. The following requirements must be met:

- The sterilizer backvent phase emissions must be vented to control equipment with an EtO emission-reduction efficiency of at least 99 % by weight.

Testing is required to demonstrate compliance with these requirements. Source testing of the emission-control system is required initially, and may be required periodically thereafter.

5.0 TEST METHOD REFERENCE

5.1 INTRODUCTION

EtO source testing will be conducted in accordance with the procedures outlined in USEPA CFR40, Part 63.365, using USEPA Method 18 as specified. EtO emissions monitoring will be conducted simultaneously at the inlet and outlet of the Safe Cell System during the entire duration of the backvent phase of one of the four sterilizers. A total of three backvent-phase test runs will be performed.

During the backvent phase, EtO emissions at the inlet and the outlet of the Safe Cell System will be determined using direct source sample injection into a gas chromatograph (GC). All testing will be conducted during normal process load conditions. All backvent testing will be performed with freshly sterilized product in the sterilizer. The testing program will be conducted in accordance with the procedures outlined in the following sections.

Operation and documentation of process conditions will be performed by personnel from Sterigenics, Inc. using existing monitoring instruments installed by the manufacturer on the equipment to be tested. In accordance with the procedures established in USEPA CFR40, Part 63, Subpart O, scrubber liquor level will be recorded.

5.2 VOLUMETRIC FLOW MEASUREMENT

Exhaust gas flow at the outlet of SC2 will be determined by 40 CFR 60, Appendix A, Method 2C, using a standard pitot tube and an inclined-oil manometer. Sampling ports will be located in accordance with 40 CFR 60, Appendix A, Method 1. The test ports will be located far enough from any flow disturbances to permit accurate flow measurement.

Temperature measurements will be obtained from a type K thermocouple and thermometer attached to the sampling probe. Exhaust gas composition will be assumed to be >99% ambient air. Water vapor will be negligible and, based on previous test data, a default ambient value of 3 percent will be used for determination of exhaust gas composition and flow calculations.

5.3 CONTROL EFFICIENCY AND MASS EMISSIONS MEASUREMENT

The EtO concentration at the inlet and outlet of the Safe Cell System will be measured simultaneously following the procedures delineated in USEPA CFR40, Part 63.365. During backvent, vented gas will be analyzed by an SRI, Model 8610, portable gas chromatograph (GC), equipped with the following: dual, heated sample loops and injectors; dual columns; and dual detectors. A flame ionization detector (FID) will be used to quantify emissions at the emission-control device inlet, and a photoionization detector (PID) will be used to quantify emissions at the emission-control device outlet.

5.4 SAMPLE TRANSPORT

Source gas will be pumped to the GC at approximately 500-1000 cubic centimeters per minute (cc/min) from the sampling ports through two lengths of Teflon® sample line, each with a nominal volume of approximately 75 cubic centimeters (cc) and an outer diameter of 0.25 inch. At the outlet of SC2 the sampling ports will be located in the exhaust stack.

5.5 GC INJECTION

Source-gas samples will then be injected into the GC which will be equipped with two heated sampling loops, each containing a volume of approximately 2cc and maintained at 100 degrees Celsius (C). Injections will occur at approximately one-minute intervals during the sterilization chamber backvent phase. Helium will be the carrier gas for both FID and PID.

5.6 GC CONDITIONS

The packed columns for the GC will both be operated at 85 degrees C. The columns will be stainless steel, 6 feet long, 0.125 inch outer diameter, packed with 1 percent SP-1000 on 60/80 mesh Carbopack B.

Any unused sample gas will be vented from the GC system back to the inlet of the scrubber.

5.7 CALIBRATION STANDARDS

The FID used at the inlet will be calibrated for part-per-million-by-volume (ppmv)-level analyses using gas proportions similar to the following:

1) 100 ppmv EtO, balance nitrogen
2) 50 ppmv EtO, balance nitrogen (audit gas)
3) 10 ppmv EtO, balance nitrogen
4) 1 ppmv EtO, balance nitrogen

The PID used at the outlet will be calibrated for ppmv-level analyses using gas proportions similar to the following:

1) 100 ppmv EtO, balance nitrogen
2) 50 ppmv EtO, balance nitrogen (audit gas)
3) 10 ppmv EtO, balance nitrogen
4) 1 ppmv EtO, balance nitrogen

Each of these calibration standards will be in a separate, certified manufacturer's cylinder. Copies of the calibration gas laboratory certificates will be included with the final report.

5.8 SAMPLING DURATION

Backvent EtO measurements will be taken for the entire duration of the backvent phase, which will be 15 minutes. This will encompass a total sampling duration of 15 minutes for each backvent phase test run.

5.9 CONTROL-EFFICIENCY/MASS-EMISSIONS CALCULATIONS

Control efficiency of EtO will be calculated for the backvent phase. Control efficiency will be calculated for each data point which will be produced at each injection interval. The time-weighted-average (TWA) EtO control efficiency will be calculated using these results. Results of the control-efficiency testing will be summarized in the final report.

Mass emissions of EtO will be calculated using the following equation:

MassRate = (VolFlow)(MolWt)(ppmv EtO/10^6)/(MolVol)

Where:
MassRate = EtO mass flow rate, pounds per minute
VolFlow = Corrected volumetric flow rate, standard cubic feet per minute at 68 degrees F

ECSi

MolWt =	44.05 pounds EtO per pound mole
ppmv EtO =	EtO concentration, parts per million by volume
10^6 =	Conversion factor, ppmv per "cubic foot per cubic foot"
MolVol =	385.32 cubic feet per pound mole at one atmosphere and 68 degrees F

Mass emissions of EtO will be calculated for backvent. The results will be summarized in the final report.

6.0 TEST SCENARIO

Backvent testing will be performed during normal process load conditions, with freshly sterilized product in the sterilizer. Three test runs will be conducted in series to verify the performance of the emission-control system. The testing schedule will be as follows:

- Equipment setup and gas chromatograph calibration.
- Backvent Test Run #1 is performed with freshly sterilized product in one of the four sterilizers. Sampling is performed at the inlet and outlet of the Safe Cell System.
- Backvent Test Run #2 is performed with freshly sterilized product in one of the four sterilizers. Sampling is performed at the inlet and outlet of the Safe Cell System.
- Backvent Test Run #3 is performed with freshly sterilized product in one of the four sterilizers. Sampling is performed at the inlet and outlet of the Safe Cell System.
- Post-calibration check performed and equipment breakdown.

7.0 QA/QC

7.1 FIELD TESTING QUALITY ASSURANCE

At the beginning of the test, the sampling system will be leak checked at a vacuum of 15 inches of mercury. The sampling system will be considered leak free when the flow indicated by the rotameters falls to zero.

At the beginning of the test, a system blank will be analyzed to ensure that the sampling system is free of EtO. Ambient air will be introduced at the end of the heated sampling line and drawn through the sampling system line to the GC for analysis. The resulting chromatogram also will provide a background level for non-EtO components (i.e. ambient air, carbon dioxide, water vapor) which are present in the source gas stream due to the ambient dilution air which is drawn into the emission-control device. This chromatogram, designated AMB, will be included with the calibration data in the final report.

7.2 CALIBRATION PROCEDURES

The GC system will be calibrated at the beginning and conclusion of each day's testing. Using the Peaksimple II analytical software, a point-to-point calibration curve will be constructed for each detector. A gas cylinder of similar composition as the calibration gases, but certified by a separate supplier, will be used to verify calibration gas composition and GC performance.

All calibration gases and support gases used will be of the highest purity and quality available. A copy of the laboratory certification for each calibration gas will be included in the final report.

8.0 FINAL TEST REPORT DESCRIPTION

The test results will be summarized in a written report. This report will be submitted to the IEPA no later than sixty days after the conclusion of the field testing. It will include results for EtO control efficiency of the emission-control device and mass emissions of EtO to the atmosphere from the emission-control device outlet. The report will contain:

- Summary tables with comparisons of the test results to rule limits;
- Copies of all intermediate data tables and calculation worksheets;
- Copies of all GC chromatograms from calibration runs and sample injections; and
- Laboratory calibration certificates for all calibration and audit gases and all applicable measurement instruments such as pitot tubes and thermocouples.